MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES, and
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE.

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.,

October 23, 1975.

PROCEEDINGS AT INQUIRY

Volume 78

ALLWEST REPORTING LTD.,
4299 CANADA WAY,
BURNABY 2, B.C.

E R R A T U M

VOLUME 76, Page 11224 line 19 and 20

should read;

MR. BAYLY: This isn't a signal that I will be a long time, it's for convenience.

APPEARANCES:

Mr. Ian G. Scott, Q.C. Mr. Stephen T. Goudge, Mr. Alick Ryder and Mr. Ian Roland	for Mackenzie Valley Pipeline Inquiry;
Mr. Pierre Genest, Q.C. Mr. Jack Marshall, Mr. Darryl Carter, and	for Canadian Arctic Gas Pipeline Limited;
Mr. Reginald Gibbs, Q.C. Mr. Alan Hollingworth	for Foothills Pipelines Ltd.;
Mr. Russell Anthony, Prof, Alastair Lucas	for Canadian Arctic Resources Committee;
Mr. Glen W. Bell and Mr. Gerry Sutton	for Northwest Territories Indian Brotherhood and Metis Association of the Northwest Territories;
Mr. John Bayly	for Inuit Tapirisat of Canada and the committee for Original Peoples Entitlement;
Mr. Ron Veale and Mr. Allen Lueck	for the council for the Yukon Indians
Mr. Carson H. Templeton	for Environment Protection Board;
Mr. David Reesor	for Northwest Territories Association of Municipalities
Mr. Murray Sigler	for Northwest Territories Chamber of Commerce

I N D E X

Yellowknife, N.W.T.
October 23, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MURRAY A. ROED, resumed:

CROSS-EXAMINATION BY MR. BAYLY:

Q Dr. Roed, with regard to the analysis that you have conducted into possible alternatives to the Mackenzie Valley route, I take it that the only basis on which you have studied these is on a terrain analysis basis. Is that correct?

A That's correct.

Q And the questions that were asked of Dr. Rutter today -- sorry, yesterday -- were, in his estimation his study, was one that recommended that an office study at least be done at this stage. Would you say the same about the routes that you studied, that a company who was interested in those routes, or a government, would be in a position to do an office study on them?

A That's correct.

Q But you haven't studied these routes with regard to environmental impact that they would have, or say social impacts at the northern end?

A No, we haven't.

Q Right. Your main thesis being, though, [illegible] be opened up at some point, in any event, because of the very good mineralization in those areas.

A There is that possibility, yes.

Q I take it that you haven't studied the methods that would be used in crossing the large lakes, Great Bear and Great Slave, but that you're relying on the fact that this is being studied in other parts of the world in the oil and gas industry, is that correct?

A Generally that's correct. The crossings that we have envisaged are engineeringly feasible at this time.

THE COMMISSIONER: The crossings that you envisage under Great Bear and Great Slave are, in your view, feasible from an engineering point of view?

A From the data that I have at hand, yes, it is.

Q Are there any pipeline crossings that exist in the world today that are comparable to the ones you propose?

A Yes, there are.

Q Where are they?

A I have several papers that document, pretty well, the latest phases of laying pipe in submarine conditions, whether it's in fresh water or marine water. I'd be more than happy to make these available to you, at your convenience.

Q Yes, well maybe you would, maybe we should have those.

MR. GOUDGE: Perhaps we should

A There is that possibility, yes.

Q I take it that you haven't studied the methods that would be used in crossing the large lakes, Great Bear and Great Slave, but that you're relying on the fact that this is being studied in other parts of the world in the oil and gas industry, is that correct?

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Q Yes, well maybe you would, maybe we should have those.

MR. GOUDGE: Perhaps we should

get copies of them, sir, and have them filed. They may be of assistance to us.

THE COMMISSIONER: Yes sir.

MR. GOUDGE: Perhaps Mr. Anthony would undertake to do that, since --

MR. ANTHONY: Perhaps the witness could just identify the areas to assist us initially and I undertake to make photo-copies of the articles, they are basically articles in trade and professional journals, and we'll make those available to the Inquiry as an exhibit and to any participants who wish to look at them.

A There are numerous techniques, and different companies that are doing this sort of thing, and it's quite involved actually.

THE COMMISSIONER: Well, I'm sure it's quite involved, and we would like you to give those to Mr. Anthony so he can file them with the Inquiry, but can you tell me of a gas pipeline that extends under water or under the bed or a sea or a lake for 50 miles or more, where has it been done?

A I'll just quickly go through these articles.

Q Sure.

A I won't read them. First of all there's the North Sea operation, they have what they call a reel ship, "Santa Fe", which expects to -- this is expected to be launched in 1977, it is designed to lay pipe up to 24 inches in diameter in deep portions of the North Sea, which could be used in water depths of 1,000 feet or more. That's the

first one, and there are several similar type designs in this paper.

Again in the North Sea, B.P., British Petroleum 32-inch underwater pipeline from Fordies Field now completed required the final connection of two sections which had previously been laid simultaneously by two contractors. Unprecidented in water depths that great, the above water tie-in was successfully completed October 14, 1974, in 322 feet of water.

Then it goes on to detail that and it says that the pipe was 32" in diameter, .75 WT, gives the grade of steel. It was corrosion wrapped and concrete coated for a total OD of 37" and negative bouyancy. There is another case. This is a summary of the Polar Gas exploration in this subject. They are looking at laying from barges to a maximum of 32" pipe in water depths of 400 feet at a rate up to one mile per day in optimum weather conditions. The actual technique, however, I think that they are really looking at now, I will just read this paragraph:

> "Polar Gas has developed a system to lay the line from the ice during a four month winter season. Studies last year proved six-foot thick ice would support heavy construction equipment including a ditcher able to cut through fifteen feet of ice and the trench would remain open long enough to allow the pipe to be laid through it."

I have some further notes here. For instance, if you are crossing a large lake, you might use two 36" pipes instead of one 48" pipe, and this would be relatively easy to manouver. I understand CAGSL is using two 36" pipes in their proposed Shallow Bay crossing, very similar conditions.

The other alternative to these, done by our research staff, you could float the pipe across lakes even to the diameter of 48". YOu would have to know the bottom configuration in detail to obtain areas where the radius of curvature was greater

than that of the pipe and the detail of bottom morphology with respect to pipe strength.

Skipping over to the Messina Strait, in the Tyrrhenian Sea near --

THE COMMISSIONER: The Tyrrhenian Sea, that is in the Mediterranean?

A That is right.

THE COMMISSIONER: I am sorry, where is that, forgive me.

A It connects the mainland of Italy with the island of Sicily. There is a 10" pipeline, 9.3 miles long which is now connected, which connects the coast of Calabria on the Italian mainland and Sicily. Completion of this line marks the first time a sea line has been laid at a depth greater than 1,000 feet.

Those are a very brief summary of the ones that I have noted in these papers. There are additional details and additional localities that you will find in this information, but it clearly indicates to me that this is an engineering feasibility at this stage.

THE COMMISSIONER: Thank you.

MR. BAYLY: Q Dr. Roed, I take it though, that you say, haven't studied either of these large lakes to see which method would be suitable either laying through ice or laying from barges.

A That is correct.

Q And you are extrapolating

from these articles that the technology exists to do it in one of those methods or a combintion of them.

A That is correct from the standpoint of the level of information that I have presented this evidence.

Q Yes. Now, you are aware, I gather too, because your route map, this gray one that you presented us with marks the Anderson River Bird Sanctuary, that one of the possible alternatives would go directly through that sanctuary.

A Yes.

Q But I notice that you have also marked that this red circle, called the area of highest probability of new gas discoveries and seems to include part of that river delta as well.

A Yes.

Q Where did you get your information about this being the area of highest probability of new gas discoveries?

A This information is obtained from a Northern Assessment Group report by Mr. Jim Shear who studied the oil and gas bearing rocks of the Mackenzie Delta and outlined his interpretation of the principal, most likely extent of the principal sedimentary basin.

Q And I notice that takes in a portion of Banks Island as part of the high probability area, is that correct?

A That is correct. This is an approximate line only--

Q Yes.

A -- I might add.

Q Now, we have heard recently or read recently in the newspapers discussion of what has been popularly called a "Y" pipeline route.

A Yes.

Q Could you tell us from the information you have where that route would be? Could it be traced on one of the maps before us?

A I have before me a map taken from "The Northern Miner" of October 16, 1975 issue, page 8, which details, in a very general way, the Y-route which I think you are referring to. I'll be happy to submit this as evidence, and shall I just --

Q Could you just trace that route so that it will be on the record as well? Then when you're tracing it on the map, you can describe for the record in words where the line is going.

A I'll just briefly explain it. Starting in the north, roughly in the area of Cameron Island, and I'm using this map as a guide, Cameron Island is just to the north-west of Bathurst Island. The line extends south-west across Melville Island and the M'Clure Strait, cuts through the centre of Banks Island, joins I think it's the Perry Peninsula north-west of Paulatuk, and then in a south-west direction directly to apparently tie in with the Mackenzie Valley roughly in the area of Travaillant Lake.

The other Y of the line extends in an easterly direction almost straight east from Travaillant Lake tie-in, passes to the north of Great Bear Lake, in between the Thelon Game Sanctuary and the Queen Maud Gulf Bird Sanctuary, and ties in with the projected Polar Gas line that runs down from the Arctic Islands on the west side of Hudson's Bay.

It ties in here along the west side, right about here. That is between Chesterfield Inlet and Wager Bay, some general area in that region.

Q And from there it proceeds south past the communities of Rankin Inlet, Whale Cove, and Eskimo Point, would that be correct, before it hits the provinces? The Polar Gas route.

A Yes.

Q Now, would you care to comment, Dr. Roed, on this proposed Y-route from a terrain standpoint, if you have information that you can give us on that?

A Well, first of all I understand, from the news media, that this proposition is presently under study by some division of government, and I have spent really no time in considering this route, these two routes. It's been a very recent suggestion. I must say that to begin with, this is the kind of general route selection which our entire evidence is trying to avoid.

We feel that we should take a look at the total spectrum of physical, environmental, and socio-economic aspects of potential land use in the Arctic before such routes are shown on a map like this. So you know, that is my principal comment from the standpoint of philosophy of route corridor selection, or transportation reasonableness.

The other one is, very basically you can take a look at the Glacial Map of Canada, and from the standpoint of considering the southern route,

this east-west --

THE COMMISSIONER: Excuse me a second, Dr. Roed. The Y is a line that would bring the gas from the High Arctic to the south along the west side of Hudson's Bay. Are you discussing that line, or are you discussing a line that -- these dotted lines, the one seems to be a line that would take the high Arctic gas to the delta and south through the Mackenzie Valley line; the other one appears to be one that would take the Prudhoe Bay and delta gas across the barrens to a point near Chesterfield Inlet, which you've already described, where it would join the high Arctic line. Is that what those dotted lines are supposed to represent?

A I think so.

Q Oh.

A I think so, I think that is the idea.

Q And your comments are -- relate not just to the Y in a solid line, but to the whole procedure, is that it?

A Well, certainly my comments relate to the Mackenzie Valley Pipeline, as we have been dealing with.

Q Yes.

A I really haven't -- I'm not relating to the Polar Gas route, you know, the principal Polar Gas route coming down to the west side of the Hudson's Bay at this stage; but you asked about the inter-connection of these two lines and you know,

that's what I was trying to answer. So that -- and I would like to restrict my answer to an example, picking the east-west connection between the Mackenzie Valley area and the east side of the Hudson's Bay as a --

MR. BAYLY: Q That's the west side, I believe.

A Yes, the west side of Hudson's Bay, to illustrate some fundamentals of terrain planning and pipeline routing.

MR. BAYLY: I believe you're about to refer to the satellite photograph.

A Yes. Well, first of all we can take a look at the glacial map of Canada and although you people can't see it from the back of the room, most of the glacial features -- that is the terrain features, the topographic features -- are orientated in a north-south direction, perpendicular to the centre line of this suggested route. Well, this at first glance, and not considering bedrock features or major depressions in the bedrock that would have to be crossed,

This indicates that this line is transecting it in the worst possible manner, terrain. That is, from the standpoint of terrain planning, what we would like to see is the transportation, any transportation route being aligned in conformity with terrain features rather than directly across them. That is the example that I would like to report.

THE COMMISSIONER: Yes, but the "Y" thing standing alone bears some correspondence to the general north-south direction of the glacial features on the map, is that true?

A That is correct and I might also add just as a first level look at the northwestern portion of that "y" coming from here, it appears to be quite well situated from the standpoint of geography and no one potential in this area, that is, it is felt that Banks Island would probably be the next area of major discoveries in the area, it is a line, more or less in direct line with Cameron Bay where the recent oil discoveries have been.

THE COMMISSIONER: That is, the first dotted lines would bring high Arctic gas to the Mackenzie Delta for transmission to the south.

A That is right.

THE COMMISSIONER: This appears to proceed on the assumption that if you didn't build this "Y" line in the high Arctic south along the west side of Hudson Bay, you'd bring the high Arctic gas out

via the Mackenzie Valley.

A That is correct.

THE COMMISSIONER: And you would pick up the Banks Island -Victoria Island gas assuming anybody finds some there,on your way out.

A That would be the logical thing, yes.

MR. BAYLY: And you aren't able to say, Dr. Roed, anything about that crossing from Banks Island to the mainland, I assume, without having done some preliminary --

A No, I am not.

THE COMMISSIONER: Mr. Blair of Foothills gave evidence and he seemed in a certain measure to agree with you about building a line that tapped the gas at Banks Island and Victoria Island along that route. Maybe that is where this paper got the idea.

Well, this is an exhibit.

(ARTICLE FROM NORTHERN MINER, OCTOBER 16, 1975, RE POLAR GAS PROJECT MARKED EXHIBIT 299)

MR. BAYLY: NOw, if I understand your answer of about three answers ago, what you are saying with regard to routes like this, your general comment was that you felt that a number of routes, all the possible routes from the possible gas sources should be studied from all the points of view, not just terrain analysis before an ultimate decision was made of which one was the most suitable to get the most resources out?

A Well, that is correct, and this more or less underlines the last paragraph in my testimony with regard to, in my opinion, a very urgent need to undertake a very comprehensive study of northern Canada resources, in physical resources and human resources and capabilities of the land. I don't know how I can be more stronger in urging that this be done immediately.

Q ANd I take it that the alternate to that is to end up perhaps with two or more expensive facilities where one might have done to get out the combination of resources that is sought, not to mention the possible terrain and social and environmental problems that might be caused by having two rather than one.

A I am not sure that I understand your question.

Q Well, you have given us an answer that suggests that an inventory should be taken of all the resources including all the mineral and gas resources, the human resources, the environmenta resources, as they be plant and animal, before deciding which is the best way to take out the largest amount of resource with the least amount of impact.

A That is correct and as long as you include all of the resources, that is exactly it.

Q And the alternate to that is to end up doing with more than one facility what you might have been able to do with one.

A That is the possibility, I suppose.

MR. BAYLY: Yes. Those are all the questions I have, thank you.

MR. BELL: I have no questions, sir.

MR. HOLLINGWORTH: I have a few.

CROSS-EXAMINATION BY MR. HOLLINGWORTH:

Q Dr. Roed, in answer to Mr. Bayly, you said that your views are restricted to terrain features, I believe, and I just wanted to clarify that because on page one of your prepared evidence in the second paragraph, you state that your views are prepared from the viewpoint of the physical environment and then on page 12 in the last paragraph you state that it is from purely a terrain point of view. Are you equating a terrain point of view with the physical environment, in other words, restricting your view of the physical environment to the terrain?

A Well, the terrain aspect of the physical environment is a major part of it. Now, the reason I use the physical environment in certain places is, that I would like to include in th the resources of the physical environment, the non-biologic resources --

Q Well, did you in fact include those?

A On the general level

consideration, yes I certainly did. For example, the minerals along the edge of the shield or in-shield terrain, potential coal resources, this kind of thing.

Q So that your view is from the standpoint of both the terrain point of view and from the potential resources of the area?

A In total, yes, we are emphasizing the terrain sensitivity in this presentation but it does include other aspects.

Q But you are including nothing more than the terrain and the resources available in the Territory, in your view?

A That is right.

Q Now, also on page one of your evidence you say that a model route should have -- sorry, should be close to the most abundant resources. Are you speaking there of the resources that we have just discussed, or are you speaking of resources for the construction of the pipeline?

A I am speaking of both.

Q And also on page 1, I understand you to say that generally rivers and valleys are unfavorable terrain for pipelines; is that correct?

A Yes, correct.

Q Still on page 1 you say:

" A flute can in some cases be in excess of 100 miles."

A Yes.

Q What is the average length as far as you're concerned, of a flute?

A I wouldn't venture a guess.

Q Well on the east of the Franklins route, you've done a certain amount of studying. Now how long would the average flute be down there, are you in a position to say?

A Oh, I would make a guess at anywhere from 50 to 70 miles long, each individual flute.

Q Were you here yesterday, sir, for Dr. Rutter's evidence?

A No, I was not.

Q Well, during cross-examination by Mr. Scott I believe he made the statement that the average length of flute in the east of the Franklins route was one mile. You evidently disagree with that statement, do you?

A I don't necessarily disagree with it, but I think that Dr. Rutter was probably talking about a different area.

Q Well, his address was on

the southern portion of the east of the Franklins route, that is to say going up to a point about equal to Wrigley or so.

A That's correct.

Q Then south.

A But Dr. Rutter's zone, which has been referred to as east of the Franklins in his evidence, is quite a bit west of the east of the Franklins corridor that is outlined in my evidence.

Q Well, how far west is it your route?

A The east of the Franklin corridor in my evidence is well east of Dr. Rutter's area that he was talking about.

Q Well east of it?

A East of it.

Q Well, how far apart are they?

A I've never measured them actually, but I would guess they are within ranges from anywhere from 10 to 50 miles.

Q Well, the difference in length of flutes go from one mile to 50 to 75 miles in that distance, does it?

A Yes, these glacial flutings are spectacular features. There are no similar features anywhere that I am aware of in Northern Canada.

MR. ANTHONY: Mr. Commissioner, since we don't have the value of a transcript I relied on Dr. Rutter's recollection. I may be corrected

but I think he makes the point of a distinction between the different routings, and his recollection of his evidence was an average of six or seven miles, and again drawing distinctions that one is farther east than the other.

MR. HOLLINGWORTH: I'm just trying to find that.

THE COMMISSIONER: I think what he said was the average was a mile or mile and a half,,and the longest was something like eight.

MR. HOLLINGWORTH: That's definitely what my handwritten notes say, sir.

THE COMMISSIONER: But at any rate, Dr. Roed says he's talking about a different area. Yours is the edge of the Shield, is that the --

A No.

Q -- it looks like it is more than 10 miles away, it looks like it's something like 100 or 200, just looking at this map.

MR. HOLLINGWORTH: Well, Mr. Commissioner, I was comparing Dr. Roed's east of the Franklins route with Dr. Rutter's east of the Franklins route.

THE COMMISSIONER: Oh, I see. Sorry, sorry.

MR. HOLLINGWORTH: Now, Mr. Commissioner and Dr. Roed, if I could refer you to page 11431 of the transcript, questions put by Mr. Scott:

"What is the average? It would be a pretty remote possibility, wouldn't it?"

He's speaking of the length of the flute.

Answer:

"Well the average, no, well the average length of the flute, you could say on a mile, a mile and a half or something of this nature, or less. You get on some flutes that are very extensive outside the area. They vary in size and I don't think saying the average really helps you."

THE COMMISSIONER: What page was that again?

MR. HOLLINGWORTH: 11431 toward the top.

Q Dr. Roed, in your testimony you seem to have conducted somewhat different methods for examining the two different routes. Am I correct in that, you had different materials to examine comparing the edge of the Shield to the east of the Franklins route?

A Only in that there was information available for the east of the Franklins route.

Q Well, did you look at air photographic material for the east of the Franklins route?

A Just in selected localitie

Q And you did the same for the edge of the Shield route?

A Yes.

Q And you also looked at ERTS imagery and published information?

A That is correct.

Q And that's the extent of your research?

A That's correct.

Q And the published information is all listed in the appendix to your submission to the Inquiry?

A That's correct. Of course it is also based on my experience in the Northwest Territories. I might point out also with regard to the granular surveys, this was done specifically for the east of the Franklin route by our staff, and that included a photo interpretation of almost the complete route, but that was strictly from the standpoint of location of sand and gravel deposits.

Q Is this the staff of Geotechnic?

A Geoconsult.

Q Sorry, Geoconsult, and who is on that staff?

A The person that did the interpretation was Janet Drysdale, Bachelor of Science, who has a field experience in the Northwest Territories.

Q I see, so the reference to the staff is to Miss Drysdale.

A In this particular case, yes.

Q All right. Now on page 4 of the evidence in the introductory paragraph, you're talking about the inappropriateness of the Mackenzie Valley, and you say:

"The reasons for this may be numerous, but emphasis is placed here on terrain sensitivity."

Now, we've already gone into what your report accentuates. But when you make that statement "may be numerous" I take it you have no proof that there are any other reasons except from a terrain point of view.

A We have limited our work to the terrain, and there are many other potential constraints in comparison with Mackenzie Valley and east of the Franklins, I just wanted to make clear that we have not dealt with these.

Q And none that you're prepared to discuss.

A Not at this particular point in time.

Q Would you be prepared to later?

A I certainly would be if the recommendations of my report are followed and the suggested attention to the proposed corridors that I have outlined have been studied in the detail that I have recommended before there is final approval of an oil pipeline, or a pipeline down the Mackenzie River Valley.

Q So you'd be prepared to discuss it if you did this further work?

A That is correct.

Q I see. In that same paragraph when you speak of the alternate route possibilities offering improved construction conditions. Exactly which improved construction conditions are you referring to?

A The improved construction conditions relate to the terrain sensitivity.

Q But it doesn't relate to construction logistics.

A It does not relate to construction logistics.

Q Well, just out of interest on page 5 here, you're speaking of an all-Canadian Winnipeg to Montreal pipeline route through Northern Ontario. Exactly what are you speaking of here?

A I'm speaking of some consideration that has been given of an oil pipeline route from Winnipeg to Montreal through Canada alone and not going down into the United States, and constructed through pre-Cambrian terrain -- much of it, that is -- of Northern Ontario, north of the Great Lakes.

Q There's already a pipeline through Northern Ontario.

A There is a gas pipeline.

Q Well, that's what we're speaking of here, in this Inquiry, isn't it?

A No. Pardon?

Q We're speaking of a gas pipeline at this Inquiry,

A Yes, we are, yes.

Q I see, so when you make that reference you're really thinking of an oil pipeline down the edge of the Shield.

A What I'm thinking of when I mentioned that, I was thinking of the edge of the Shield corridor, the general classification of a zone where perhaps more than one utility could be placed.

Q All right, and further down that page you're talking about passing within 100 miles of Brandon, a major distribution centre, and I was just wondering what particular advantage there was of passing within 100 miles of Brandon, Manitoba?

A Well, from the standpoint of the overview treatment given in this Inquiry, my evidence, I mention it because there is the flexibility, I would think at this stage, to tie in directly with Brandon because it is a major distribution centre of oil and gas pipelines.

Q Well, I suggest to you, sir, that if the present configuration was used, that is going down to the vicinity of Calgary and then west along existing TransCanada line, that you would go right through Brandon, that might be even better than coming a hundred miles from it.

A Well, that is correct, but if the Edge of the Shield corridor is located along the edge of the Shield in that general area, then it would be a mere one hundred miles to connect with any transportation system at Brandon, if that desire was there. That is the only point that I would like to make there.

Q Well, now, looking at this map that is in red and gray, and I forget which figure number that is, figure one, I think, it appears that the Edge of the Shield route goes from the southeast corner of Wood Buffalo National Park diagonally southeast into Saskatchewan. I presume it goes in more or less a straight line from there to 100 miles from Brandon, is that correct?

A That is correct, but I wish to emphasize that the main part of my evidence is related to north of 60 parallel.

Q Yes, but conceptually this would be your theory south of the 60th parallel.

A Conseptually, yes.

Q And this would involve an entirely new pipeline, for either gas or oil.

A It would involve an entirely new corridor, yes.

Q And a new pipeline.

A Yes.

Q So that the existing facilities which are presently in Alberta and part of the TransCanada line would just go wasted under this conception.

MR. ANTHONY: You are referring to the portion now from Calgary to Brandon, are you?

MR. HOLLINGWORTH: I am referring to the portion of Rainbow Lake down to Calgary and over to Brandon.

A I understand that new pipeline facilities are going to be required in any event.

Q Well, there is going to be looping required. Do you understand that there is going to be anything beyond looping required?

A Well, yes, I understood that there is an entirely different line.

Q An entirely new line from --

A That is right --

Q --Rainbow to Brandon, this is what you understand?

A Oh, no, not to Brandon.

Q Where to?

A Well, to -- I just forget

the name of the town --

Q Was it Emerson, maybe ?

A In Alberta?

Q No, Emerson, Manitoba.

A I am thinking of CAGSL route.

Q Well, I realize that

A Well, I understand they are going to need new pipe, a completely different pipeline.

Q Well, this is a point of difference between Mr. Carter and myself, but I think he will agree with me that the Arctic Gas scheme doesn't call for anything beyond looping of the TransCanada line from Calgary to Brandon.

A Oh, yes, all right, yes I understand.

Q You will agree with that.

A Yes.

Q So you will agree with my statement that you are calling for a brand new line where none is presently called for now.

A A new corridor, yes, right.

Q And a new line.

A Right.

Q Now, just discussing Wood Buffalo National Park, perhaps you could give me some detail as to where exactly your corridor goes

once it gets to the south side of Great Slave Lake, from there to, let's say, Fort Chipewyan.

A There are many options and I have on the basis of the existing information thatI have presented to this requiry, have attempted to outline a zone or a corridor along which detailed studies so I could answer your question, could be -- well, could be answered, could be dealt with.

Q As I understand this corridor now, it appears to go south along the boundary of Wood Buffalo Park and along the shores of the river past Fort Smith andthen south to Fort Chipewyan. Is that a fair assumption?

A Generally, yes.

Q So that following the river valley that you previously said is unsatisfactory.

A This is in Precambrian Shield terrain which is considerably different than the terrain in the Mackenzie Valley, there is no way that you can compare the two.

Q So that it would be satisfactory to go along the river in this kind of terrain, is that your evidence?

A No, that is not my evidence. My evidence is that this is a zone that requires further detail.

Q Have you had any discussions with the National Parks as to their feelings of a pipeline corridor going down the boundary of Wood Buffalo Park?

A Well, for the information of this Inquiry, yes, I have talked to park officials and they are certainly interested in the developments that are being considered in the Northwest Territories.

I have talked to them, yes.

Q Have you had any correspondence with them on paper?

A No, I have not.

Q Now, on the crossing of the Great Bear and the Great Slave that you have proposed for the Edge of the Shield, you have stated in evidence that the depth would not exceed 300 feet and I assume you made studies of something to arrive at this, have you?

A That is correct.

There is information available in the Department of Mines and Technical Surveys of piezometric surveys of both lakes.

Q And do these studies also show the dropoffs from one depth to the next, if you like?

A The studies are general in nature. There are no details provided in my evidence to answer that question.

Q So if for instance the depth of Great Bear suddenly went from 50 feet down a sheer cliff to 200 feet, you don't really know that that exists, do you?

A That is correct, except that I have indicated that studies on bottom morphology

and bottom sediments would have to be done in connection with any idea of laying pipe along the bottom of those lakes.

Q Do you have any information or studies as to what the nature of the bottoms of these lakes is now, any at all?

A I do not have any except what is on the maps, and they are general.

Q Do the maps indicate whether the bottoms of these lakes freeze or what kind of materials they are?

A No, they don't.

Q So you don't know if there are going to be frost heave problems or anything of that nature on the bottoms of these lakes.

A Well, just a general knowledge. I am sure that Great Bear and Great Slave do not freeze to a depth of 300 feet.

Q And have you studied the construction cost that might be involved with these methods of construction?

A No, I have not.

Q Have you any idea at all on how much the construction would cost as opposed to crossing land?

A No, I do not.

Q So, if I suggested to you that it would be in the neighbourhood of three times the cost, would you be in a position to disagree with me?

A No, I would not.

MR. ANTHONY: I wonder, Mr. Commissioner, if it wouldn't assist the Inquiry if Mr. Hollingworth has such studies that indicate that and I am wondering if he could make that available to us and maybe we can discuss the question further when we get into discussions of corridors.

MR. HOLLINGWORTH: I have no written studies, Mr. Commissioner.

THE COMMISSIONER: No studies that show that Great Bear freezes to a depth of 300 feet.

MR. HOLLINGWORTH: Certainly not.

THE COMMISSIONER: It is unlikely that there would be permafrost under either of those lakes, isn't it?

A Gee, well, I really wouldn't comment on that because we are finding permafrost in the most unusual localities. I certainly would keep an open mind on that.

MR. HOLLINGWORTH: Well, in any event, I think you are speaking of laying the pipe on the bed of the lake and not burying the pipe, aren't you?

A That is correct.

Q Now, on the East of the Franklins corridor, you talk about two major river crossings, and that is the Great Bear River and the Mackenzie River at Fort Providence, but isn't there

another one? If you have got to get gas from Richards Island to your East of the Franklins route, don't you have to cross the Mackenzie again?

A The evidence that I have presented starts at Sitidgi Lake and goes south.

Q Well, would you go so far as to agree with me that if the gas is on Richards Island it would require a major river crossing there just as there is one now, to get over to your route?

A Perhaps I would, but in the light of my other -- my knowledge about the Mackenzie Delta and getting gas out of it, I feel the knowledge of that whole general area is at a very early stage with regard to a gas gathering system, and that is a very complex problem. I simply think it is an entirely different subject and certainly not related to my evidence.

Q Well, why is it complex? If you have got gas on an island and you have to get off the island onto the mainland, don't you have to make the river crossing?

A Well, I just want to repeat that I am not here to comment on the Mackenzie Delta. I am here to comment and give evidence on potential alternate routes from Sitidgi Lake to the 60th parallel.

Q Well, Dr. Roed, you have given evidence of where the main gas bearing sediments are in the area around the Beaufort Sea. Now, the

gas that has been discovered is basically on Richards Island, do you agree with that?

A Yes.

Q And don't you agree with me that to get from Richard's Island to where your route commences you have got to cross the Mackenzie River.

A It would seem that way, yes.

Q So you have got a third major river crossing on your East of the Franklins Route,

A No, I do not have a third major river crossing on East of the Franklins Route. The East of the Franklins Route stops at Sitidgi. What you do beyond Sitidgi is an entirely different study, an entirely different area of influence from a terrain standpoint.

Q Now, on page 8 you make the statement that service to communities would be less from your -- I believe it is Edge of the Shield Route.

Yes, it is. Are you making the statement that you do in paragraph 8.3 of your evidence on the basis of looking at a map and examining distances, or have you made any greater study than that?

A I have not made any greater study than that.

Q And in any event, that cost could be offset by the greater cost to the mainline down the corridor.

A I haven't studied that either.

Q Now, it appears that this report which you distributed yesterday has some figures in it on logistics.

A Yes.

Q And this is part of your evidence, is it, that you have given before the Inquiry, or do you intend it to be part of your evidence?

A It was designed or done to back up a general comparison with regard to logistics, and it is simply backup research material.

Q Well, did you consult any studies other than those listed in your list of reports to come up with these figures?

A Yes I did.

Q And can you produce those documents?

A Yes, I can.

Q Can your counsel undertake to do that for you?

MR. ANTHONY: Yes. As I understand, you're enquiring whether any further study beyond those listed were done on the logistics question.

MR. HOLLINGWORTH: That's correct. Now Mr. Anthony, I wonder if I might confirm at this time that you're prepared to bring Dr. Roed back to be further cross-examined on the new material which was presented yesterday that was over and above the material forwarded to the participants at an earlier date?

MR. ANTHONY: Well, I think as I made it clear, yesterday the information that's available there was prepared as backup information so that any questions raised could have some source of knowledge rather than the usual case where the witness presents a statement and says, "There are studies that are available" to him.

Now if my friend feels that somehow he can't handle that material and wants Dr. Roed back, then I'm prepared to call him back. But I'm not going to undertake to bring him back unless my friends feel they are unable to cross-examine at this time.

MR. HOLLINGWORTH: Well, Mr. Commissioner, yesterday Mr. Anthony raised the point that there was a draft appendix to the report filed by Dr. Roed, which delved into environmental issues, and he's quite right, there is. He didn't mention that

there was further material on the logistics of the construction plan, and it came as a bit of a surprise to me to read it last night, and frankly, I would like the opportunity to have my advisors look through this material, and if in fact they feel some cross-examination is warranted, then I just want it to be clear that Dr. Roed is prepared to re-attend.

MR. ANTHONY: Well certainly, if on the basis of the logistic study and other studies that are there, there's a request to bring him back I will bring him back at a convenient time.

THE COMMISSIONER: All right, fine.

MR. ANTHONY: I want to make it clear that the environmental part we do not propose to call Dr. Roed or necessarily anybody to give evidence on the environmental --

THE COMMISSIONER: Well you're not relying on that?

MR. ANTHONY: That's correct.

THE COMMISSIONER: So it is as if it didn't exist. You don't even want me to read it.

MR. ANTHONY: That's correct. It's presented only as it was part of a total report that was -- had to be cut back, and we were unable to --

THE COMMISSIONER: Yes. Well at any rate at this stage of the game you're saying that you don't even wish me to read that environmental assessment in that report.

MR. ANTHONY: I'm not presenting the environmental section of that report as evidence before the Inquiry.

THE COMMISSIONER: All right, so --

MR. HOLLINGWORTH: That's the Appendix "E", Mr. Anthony, the environmental overview of east of the Franklins route and comparisons to the Mackenzie Valley route.

MR. ANTHONY: That's correct.

THE COMMISSIONER: Well, let's stop for coffee. Is that all right, Mr. Hollingworth?

MR. HOLLINGWORTH: That's fine.

(PROCEEDINGS ADJOURNED FOR A FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Go ahead, Mr. Hollingworth.

MR. HOLLINGWORTH: Mr. Anthony has something to say.

MR. ANTHONY: Mr. Commissioner, before we proceed, it appeared from conversations during the break, there was a distinction between the evidence of Dr. Rutter and Dr. Roed about the location and size of flutes which left some people in some confusion. Perhaps Mr. Hollingworth, perhaps not; and I thought it may assist the Inquiry if Dr. Roed just clarified his evidence as it relates to Dr. Rutters, in case Mr. Hollingworth wishes to pursue the question further.

THE COMMISSIONER: O.K., go

ahead, sir.

A Well, just briefly I'd like to point out that the area that Dr. Rutter was reporting on is just to the west of the fluted range that I am talking about along the east of the Franklins route and in that area the flutes are of the size that Dr. Rutter has indicated; but along the east of the Franklins route which I am presenting, the flutes are in the order -- some are -- 100 miles long. I would like to reaffirm the evidence that we have presented in a report, my testimony, that the flutes are as I have outlined them.

One other thing, these are fluted moraine, individual ridges can be distinguished on the ERTS aerial photograph which is behind me here, and I'd be happy to outline a number of flutes that are in the order of 100 miles long at the convenience of anyone who is interested.

THE COMMISSIONER: Fine, thank you.

A I also have a magnifying glass for anyone who needs it.

MR. HOLLINGWORTH: Q Dr. Roed, on page 6 at the top of your evidence, you state that:

> "There is more abundant construction material throughout its entire length compared to the Mackenzie Valley corridor,"

and I think you're referring there to the edge of the Shield route. What construction material are you referring to there?

A Sand and gravel.

Q Gravel, did you say?

A Sand and gravel, yes.

Q Now, when you put together the construction figures and when you made the statements you have in the prepared evidence, had you previously obtained any views from pipeline contractors?

A No, I hadn't.

Q Have you obtained views from any contractors?

A No, I haven't.

Q As I understand you, on the east of the Franklins route at least, am I correct in saying that you haven't worked out logistics for an edge of the Shield?

A That is true.

Q For the east of the Franklins you're talking about access points at Providence, up the Great Bear River, and at the northern end of the route around Sitidgi Lake.

A Major staging area.

Q Major staging area.

A There is one other one up to Rory Lake area.

Q And how would access be gained to that staging site?

A Winter road along the valley.

Q Winter road, is that through a pass or over the mountains?

A That's through a pass.

Q How high is that pass?

A It's not a pass, it's a valley.

Q I see, and how high above sea level does it get?

A Well, I don't know. It's you know, a general plan that was presented.

Q I see, and how long would that road have to be from the Mackenzie River to the staging area?

A We can measure it on the map, but --

Q Well, do you have an approximate figure?

A I think about 20 miles. 20 or 30 miles or so.

Q So that of course you'd really have to have two staging areas because the pipe and other material comes down the river or up the river in summer, and then you'd have to leave it there until you got your winter road built, and then transport it in on these trucks

A That's correct.

Q All right, and am I correct, did I interpret you correctly as saying that you're speaking of trucks that can carry ten 40-foot joints of pipe?

A I understand that's what is being employed along the Alyeska Pipeline route at

the present time.

Q And that's what you're considering here?

A Correct

Q And have you looked into how much that will weigh?

A No, I haven't. I know that they are transporting these pipes using two 40foot carriers behind the tractor.

Q On the Alyeska line?

A Yes.

Q Is this in one of the reports that you're going to produce?

A No, that's just general knowledge.

Q Did you take into consideration any environmental issues, and particularly living environmental issues, in coming up with the corridors which you have?

A Just on an indirect -- in an indirect manner. We primarily looked at the terrain.

Q Well then, I suppose you're aware that the logical northerly extension of your east of the Franklins route goes through the middle of the reindeer grazing reserve.

A That is a good example, yes.

Q I suppose you are aware too that your Edge of the Shield corridor goes through the grazing area of the Bluenose Caribou herd.

A That is correct.

Q And so that the statements you made to the Canadian Society of Petroleum Geologists and Exploration Geophysicists were not quite accurate when you said that you would go around the Bluenose herd with your Edge of the Shield Corridor.

A Well, the detailed distribution of the herd's route, migration and so on, would be a subject of fairly intensive analysis and further choosing the appropriateness of either one of these routes.

Q Well, let me get this straight. You recall your address to the Society of Petroleum Geologists and Exploration Geophysicists?

A Yes.

Q And that was made on May 23rd in Calgary of this year.

A Yes.

Q And correct me if I am wrong, but I am reading from page 6 of your preliminary draft, and this was evidently distributed to the participants, and you say there, quote:

"The only caribou herd infringed upon is
the small Bluenose herd north of Great Bear

Lake and the route is substantially east
of its common range".

Do I understand you now to be changing that testimony, or changing that view?

A No, I am not changing it. I just have not included it in the evidence for this Inquiry because I am restricting my evidence to the physical resources and terrain sensitivity .

Q Well, do you feel capable of commenting on that statement at this time ?

A My statement stands, that is exactly -- I do have the publication available if you would like it.

Q I would like it if your counsel could produce it, yes, sir.

A Fine.

Q Now, what do you mean by a "small" herd?

A Well, it's, you know, it is a smaller herd -- it is about the smallest herd in the area, in the whole region.

Q Well, are you aware how big it is?

A No, I don't

Q And you still maintain that your route would cross substantially east of its common range, do you?

A That is right. East of the Edge of the Shield Route, yes.

Q All right.

MR. HOLLINGWORTH: Those are all the questions that I have.

THE COMMISSIONER: Mr. Carter.

CROSS-EXAMINATION BY MR. CARTER:

Q Dr. Roeds, if I could refer you to the first page of your direct evidence, in the third paragraph toward the bottom, you refer to "the compendium of inevitable developement interactives that follow the leader."

Now, that is quite a mouthful, but I think that I understand what you are saying, your concept; and I wonder if you have an example of that particular concept, where that has occurred?

A Well, the example that comes to mind right away is -- take the TransCanada Highway and the railroad that goes through Banff National Park, for example.

Q Have you an example where a gas pipeline went into an area and was the leader --

THE COMMISSIONER: Excuse me, Mr. Carter, I am sorry, that example you gave, what is the point -- that the railway was built and then the highway followed the route of the railway, is that what happened?

A That is basically what happened, yes, and you have a lot of other things happening in the area to capitalize off various resources that are connected to the valley.

THE COMMISSIONER: Yes, carry on, Mr. Carter.

MR. CARTER: I wonder, sir, if you can think if an example where a gas pipeline was the leader and these other things followed?

A I don't believe I can, not offhand.

Q Do you consider that this concept applies to the present case that we are considering, namely the Arctic Gas and Foothills proposals?

A In relation to the terrain sensitivity and the resources that are available along the Mackenzie River Valley, yes, I do.

Q I wonder, sir, if I can suggest a different idea and ask you to comment on i and that is in the case of each of these routes following the Mackenzie Valley, that there is in fact already an existing corridor and this started because of nature and the river and following that there is the barging system and then CN's Tellecomunication system, winter roads, air routes, airports, highway under construction

A What is the question?

Q Well, the question is in light of that do you still feel that Arctic Gas and Foothills Pipe Line would be the leader in this valley?

A Insomuch as it's the leader of human activity, yes. The Mackenzie Valley is a natural waterway and that is very clear, it is a natural corridor to the Arctic Ocean, but man has the ability either to use it wisely or not, and that is the

fundamental difference in the Mackenzie Valley route as opposed to the East of the Franklins or the Edge of the Shield, the alternatives that are being put before this Inquiry. We are the humans that are attempting to evaluate the resources, socio-economic implications of all of these alternates and not necessarily following nature, but trying to determine nature's sensitivities and conforming our activities to them.

Q Well, maybe I didn't understand then what you meant by these words. I had thought that what you were saying, and one of the other terms you use, is a single facility is established, once a single facility is established. Once you get this pipeline and it is the first thing, a lot of things are going to follow, and I was suggesting to you that we already have a lot of other things that exist in the Mackenzie Valley that in fact your concept is not applicable to it.

A Well, we certainly have a river which is a natural waterway and we have settlements along the river. Insofar as that is concerned, yes, I would agree with you. But with respect to actually developing that river valley, that is, as people trying to utilize the land and resources in this manner, I feel that the Mackenzie Valley is quite inappropriate from that standpoint, but in comparison with the East of the Franklins, and the Edge of the Shield Route.

Q I take it you say that

because you feel that looking at the north as a whole, the resource potential is better on the East of the Shield Route.

A I would think so.

Q And by resources there you mean hard minerals in particular?

A I think there are two aspects to the resources of the land terrain sensitivity compared to the Mackenzie Valley and also the ultimate possibilities of development of the Edge of the Shield mineral potential.

THE COMMISSIONER: Excuse me, Dr. Roed. Would you mind using the table mike instead of the hand mike, because it is easier for the court reporters to hear what you are saying. I am sorry to interrupt you.

A It wasn't working a few minutes ago, sorry.

MR. CARTER: Okay, so you say that the mineral development -- I take it you are using mineral in the sense of minerals other than oil and gas.

A That is correct.

Q I take it that you don't consider that the pipeline in itself ought to be built where minerals other than oil and gas occur to develop those minerals but it must be something else, and I think, you state in your evidence a railroad is the most obvious and also a highway. In other words, a gas pipeline is for natural gas and it

doesn't really help you a lot to get hard minerals out of a particular area. YOu need highways or a railroad.

A That is right, but the Mackenzie Valley route, there was a highway planned there anyway and the principle here is that sooner or later it is felt that the possibility of developing the Edge of the Shield mineral potential is going to be presented before the people of Canada.

Well, my theses there is simply that perhaps to avoid building two major transportation routes to northern Canada resource centres, perhaps we should just consider one which is located in the best overall place which is the Edge of the Shield.

Q And as I understood from your background, you had a particular interest and history in that area.

A That is correct.

Q Now, if I could turn to your Edge of the Shield again and your starting point, you state that it starts at the geographic centre of the Mackenzie Sedimentary Basin, and I believe my friend, Mr. Hollingworth, referred to this as well.

Do you in coming up with your starting point for the Edge of the Shield corridor, you look more at the sedimentary basin rather than where the studies have been to date.

A Yes sir.

Q So that as far as you know, there would be no discoveries of natural gas on Banks Island or the Tuk Peninsula east of Parsons Lake field.

A That's right.

Q Are you aware of the applications that the producing companies, Imperial, Gulf and Shell, have filed where they intend to have their feeder lines and gas plants?

A No, I'm not.

Q I take it that as your edge of the Shield route continues on south, the main reason or at least one of the main reasons that you prefer it to the Mackenzie Valley route is because the terrain is better, and you say that because generally you expect less ice will be encountered.

A I would expect so, yes.

Q Have you any field evidence on which you base that opinion?

A No, I do not.

Q If I could turn then to the mile by mile routing of this edge of the Shield route, on page 6 you start with your first section, Mile 0 to Mile 25, and this is the crossing from the Tuk Peninsula to the mainland east of the Anderson River, that's principally a water crossing and I intend to deal with the water crossings later, so if I could move onto your next section, Mile 25 to Mile 100. I take it that it's your position that the

terrain in this area is relatively ice-free.

A No, it is not. I think that I've indicated that the first 15 miles is particularly severe, from the information that I have.

Q And what about the balance?

A It's all in a zone of permafrost, permanent permafrost, and I would expect that the ice conditions would be -- reflect its presence. However, the nature of the materials indicates in general that there is a good possibility that you may find minimal ice conditions in the surficial deposits there.

Q Well, I'm just not clear. You say:

"overall but east of the Shield route is going to be better because it's going to encounter less ice content in the terrain."

Is the section that we're dealing with now, Mile 25 to Mile 100, an exception to that?

A No, the northern section in the permafrost, permanent permafrost zone, these comments apply to that general area; but the longest part of the section, I believe, is in the discontinuous zone which is south of Great Bear Lake.

Q We've drawn a rough map of your route, and Mile 100, which is the furthest southerly point in the section I'm dealing with, is at approximately a river called the West River. Now

your comments about the high ice content, because of the permafrost, do they not apply that far south?

A I would expect that we could locate the general corridor in that entire area from, apart from this difficult area near the coast, right down to the Great Bear Lake, in terrain which has the greatest possibility of low ice content.

Q You've given a number of references in this section, again talking about Mile 25 to Mile 100, and one of these is, Yorath if you could look at your direct evidence, sir, Yorath is cited and the year that's given is 1959. I wonder if that should not be 1969?

A Oh yes, of course, that's - yes, it is, sorry.

Q And do you conclude anything from his report about the ice content of the area?

A No, I do not, except from the standpoint of general regional conditions, the area generally speaking is a till covered upland underlain by presumably this gravel layer in many places, which again is underlain by the pale shale zone rocks. Just the character, the general character of that upland has in comparison to, for example, an area that has substantial glaciolacustrine silt and clay in it, and which is a lowland like the Mackenzie River, in comparison the chances of ice accumulation are quite significantly reduced in an upland area, as compared to the Mackenzie Valley area, which is the principal

point, you know, the fundamental point in that northern terrain.

Q Do you have any on-site information apart from that in the literature that you've given in these citations here?

A Just the evidence I presented.

Q Now, one of the other features that you refer to is the remarkable series of abandoned stand lines, and I take it these are in the area which we're talking about.

A Not necessarily. I mention it in the context of very interesting terrain features from an engineering viewpoint. I do believe they are east of the edge of the Shield route, but their delineation has not been complete.

Q Well, you're dealing with the edge of the Shield route on a mile by mile basis, and you refer to these strand lines, but I take it that they're just added for information and that they don't really exist in the area you're talking about.

A There is a possibility that this, you know, with further definition that the edge of the Shield route could be considerably altered route on the basis of environmental considerations, socio-economic considerations, or a number of other considerations. I mention the strand lines because they are a feature of that northern terrain along -- especially along the coast. My evidence does not suggest that they are specifically in along this particular line

that I described, I didn't intend for that to be --

Q I take it then you're aware that in Craig's Report he says that there is no evidence at all that they're in that area.

A In Craig's Report, in that specific area, yes, but just to the east they are.

Q How far east?

A Well, 40 or 50 miles, I can't remember exactly.

Q If I could move onto the next section, and this is Mile 100 to Mile 250, you refer to the Glacial Map of Canada, and relying on that, state that it's an area of extensive and thick moraine deposits.

A Yes.

Q Now, on that same map -- this is the Glacial Map of Canada, 1967 -- and correct me if I'm wrong, the Tuk Peninsula around Liverpool Bay area, the adjacent Tuk area, is described in the same way, is that not correct?

A Excuse me. It is described in the same way.

Q Now, what can you tell us about the ice content of this area?

A I would expect you would have the same kind of ice content as you would in an area, and the same kind of materials along the Mackenzie Valley route. The same possibility.

Q Are you aware that recent work in the Tuk area that is described in the same category in the glacial map has found that these moraine deposits are ice-rich and that the topography is largely the result of ice core hills and depressions due to melting of ice?

A No, I am not familiar with that specific detail of knowledge. I know that there are ice-rich areas of the till in that general region.

MR. ANTHONY: I wonder if Mr. Carter can assist us in identifying that report and perhaps making it available so that it can be commented upon at a later date.

MR. CARTER: We can do that, sir.

MR. GOUDGE: Mr. Commissioner, I am advised that Dr. Rampton's report done for the Environmental Social Program, that contains that information.

MR. ANTHONY: I believe that is not correct.

THE COMMISSIONER: Dr. Rampton is shaking his head.

MR. GOUDGE: I am sorry. I apologize, sir.

MR. CARTER: It is another report and we will get that, sir.

Q Now, the next section on your mile by mile discussion is the crossing of the

Great Bear Lake and I will leave that until the discussion of the lakes later.

Then moving on, you have a section from Mile 400 to Mile 700, and again , here, you refer to the strand-lines, and I wonder if you could tell me how much of the area between these two mileposts you expect to be this type of material.

A Well, I can't tell you that exactly, but what I can tell you is first of all the entire area appears to be sandy in nature due to deposition in Glacial Lake McConnel. The strand-lines that I am referring to, for example in the northern part, follow topographic provinces, they are old beach lines and the follow the contours of the land. So in the northern section, to follow the really well developed strand-lines would be impractical from the stand point of pipeline construction, however, there are other associated deposits, or related deposits, surficial deposits, that could be utilized, I believe.

Q Have you any ground truth data on the ice content of this area?

A No, I do not.

Q In the next section you arrive at Great Slave Lake. I would like to ask you some questions and in these I am referring to your lake and your water crossings as a whole.

You have told us about some of the engineering developments with respect to water crossings and have referred to a number of articles

The North Sea, I take it, is the best example of the present technology?

A Well, I would rather -- there are several different technical examples in the papers. I am not here to pass judgment on the best example of submarine technology.

Q You have read these papers, I take it, that you --

A I have perused them, yes. I have not studied them in detail.

Q Do you know what length of pipeline they have underwater?

A I can't give you that information offhand, no.

Q I take it that you haven't done very much study then on this concept of the water crossing of the lakes.

A That is correct. We have done enough study for an overview analysis of the alternate routes as proposed in this evidence. We would envisage dealing with these details in later phases of analysis, and I refer again to the planning structure that I have outlined in my report and relate that -- all my evidence is related to the first stage of planning, that is, a general overview of the broad area of the western Northwest Territories.

Q So you haven't done more detailed examination of the problem of compressor stations that would be required to get the gas out --

A That would be in follow up stage of study, that is right.

Q Have you any estimate of what length of time we'd be looking at before these sort of developments could be brought to such a stage that the project could be undertaken?

A Well, you mean to bring it to final design stage?

Q Yes.

A All of the various studies -- which route are you talking about?

Q Well, we have been hearing evidence from the Arctic Gas witnesses about the designs that they have for the pipeline and they have stated that they feel it can be built. I am just wondering how long in the future we would be looking at before engineers could say the same thing about crossing these lakes.

A Yes, I understand. Well, firstly, it depends on how many people you have working on a project and how well it is organized. There are so many ifs in a study like that. But speaking of the East of the Franklins Route, as compared to the Edge of the Shield Route, I think that I can safely say that the East of the Franklins Route could be evaluated in a much shorter time than the Edge of the Shield Route.

Q Is that principally because of the problem with the lake?

A That's correct.

Q Now, --

A But not entirely, I might add. The terrain along the east of the Franklins route is in many ways ideal, and these fluted moraines extend for a very, you know, extensive distance, and we just don't have comparable features that are so easy to work with along the edge of the Shield route. So just by the very nature of the terrain, you're certainly going to save a lot of time by going down east of the Franklins.

Q I see. The examples you gave of the North Sea I recall in particular, were they all cases where it was necessary to get the gas from the point where it was at to the point where it would be used to cross the water? What I'm driving at is, as you said in your evidence, you don't have to go through Great Slave or Great Bear Lakes if you go around them, but in the North Sea I take it that they have to get the gas to the mainland and therefore have to go through water. Is that a fair statement?

A Yes sir.

Q Why then do you propose going across the lakes rather than around them?

A Well, I'm looking in terms of the shortest distance between two points.

Q So that on the edge of the Shield route it would be considerably further to

go around the lakes.

A Very considerably.

Q And at least in the case of Great Bear Lake you'd have to have some sort of a road into there and around the other side of the lake to bring the materials in. If I could move on then to the east of the Franklins route, as I understand it, the reason that you like this route is because of the fluted moraine, the long flute that you referred to.

A It would appear to be an excellent place to place a linear pipeline construction.

Q And again, as I understand it, that's because the crest, at least, of the flute is well-drained and therefore you expect that you will not encounter very much ice.

A I expect that the ice content will be minimal along the crest of the flutes.

Q But as yet you have no ground proof data to confirm this.

A That's correct.

Q I'm advised, sir, that for example, there is a D.P.W. borrow pit in Inuvik in the crest of a drumlin and right in the crest there is very ice-rich materials. Would that surprise you?

A No, it wouldn't. That is in a permanent permafrost area .

Q I take it there's a difference between the fluted moraine further north and the southern part.

A I would expect there would

be, yes.

Q And part of the northern fluted moraine that you have on your figure 1 is in this permafrost area.

A That's right.

Q Now, as you stated, your east of the Franklin route or corridor goes only as far north as Sitidgi Lake.

A Yes.

Q And I suppose just as Mr. Rutter took us to a point on the east side of the Franklins, you take us further to the north, but you can't tell us where you intend to go north of that.

A Well, not precisely. Of course they have to be connected to the producing areas so there would have to be additional water crossings.

Q I take it that to be consistent with your philosophy of looking at overall development in an area, one couldn't just bring a corridor part-way, you'd have to look at where it ended up going.

A That's right, and the whole question of delta distribution/the gathering system would have to be considered from the standpoint of terrain, all the elements that we're talking about in this evidence.

Q But you haven't done that as yet.

A No, we haven't.

Q On page 9 dealing with the fluted moraine, about half-way down the paragraph at the top of the page you say:

"The material forming the ridges is believed to be a fairly uniform stony till."

A Yes.

Q I take it from that --

THE COMMISSIONER: Page 9?

MR. CARTER: Yes sir, about six or seven lines down.

Q Do you have any information as to whether or not there might be a fairly large content within these flutes of large boulders?

A Yes, I think that this evidence has been produced by Dr. Rutter, who was describing the --

Q Have you --

A -- similar but not identical flute features to the west, and this is a -- one of the features of the flutes that they at times have large boulders at the crests.

Q Could you give us an estimate, Dr. Roed, of how much of the route is on the flutings and how much is in areas where you wouldn't be able to stick to the flutings?

A Okay. May I just refer to a map and sort of just give a general idea?

Q Sure.

A Well, just as a general estimate, I would say somewhere between -- well, perhaps as high as 60% of the route between Fort Providence and Sitidgi Lake would be on the flutes.

Q Then north of Sitidgi Lake ---

THE COMMISSIONER: Between Fort --

A Between Fort Providence.

THE COMMISSIONER: That is East of the Franklins.

A Yes, along the East of the Franklins corridor.

THE COMMISSIONER: Right, right right.

MR. CARTER: And then north of Sitidgi Lake we don't know what the route might be, but whatever it was, it would not be in the fluted moraine, I take it.

A That is right. It would be in more of the delta, you know, the Mackenzie Delta type terrain.

Q Now, there are two general areas shown on figure one of fluted moraine, the northern one and the southern one. Is it fair to say in the southern sections the flutes are not as well defined and that you may have more problem there with swampy lowland?

A No, on the contrary, in the southern section they are even better defined than in the northern section.

Q So the northern section would be the more difficult?

A They are just not as well developed. I don't know whether it would be more difficult or not or whether that would -- it is more difficult because you are in the permanent permafrost zone, so inherently there are going t o be more problems with regard to ice content.

Q So the percentage of lowland is possibly the same in both the north and the south?

A There is very small percentage of lowlands along the entire route, very small.

Q Now, also on page 9 you have set out the terrain advantages of the fluted moraine and the first one is river crossings. I wonder, sir, if the advantage of the river crossings is really that related to the fluted moraine or whether it is not simply the fact that the river crossings on the east of the Franklins Route are, because of I

suppose, the fact that they are not between the Franklins and the Mackenzie River where the rivers have deeper valleys. Their river banks may not be as steep. I am just wondering if --

THE COMMISSIONER: Well, they are closer to where they rise, isn't that the point?

A Well, I think the point is I have probably included an overall advantage of the East of the Franklins Route under the heading of advantages of fluted moraine and your point is well taken. But the combination of the two is --

THE COMMISSIONER: But I have got the point, haven't I? I mean, if you are close to where the river rises, you have got less water and presumably a smaller riverbed to contend with.

A That is correct. It is a happy coincidence, the combination.

THE COMMISSIONER: And it has nothing to do with the fluted moraine?

A Not per se, no.

MR. CARTER: Now, in your section on river crossings, you state that there are only two minor crossings, namely the Kugaluk River and the Hare Indian River, I believe that is headwaters, and I am advised that a number of other rivers are just as large as these two and I am referring to the Iroquois, the Minor, the Wolverine, the Willowlake, and the Horn and I am wondering whether or not you agree with that.

A Well, compared to,you know, the sort of general catagory of minor river crossings in the Mackenzie Valley, I certainly don't. There is a considerable difference between the characteristics of the so-called minor river crossings along the Mackenzie Valley route and the minor ones along the East of the Franklins.

Q What about as compared to the two you listed, the Kugaluk and the Hare Indian?

A Well, you know, I haven't really looked at it in that much detail and perhaps I should include maybe one or more of these minor streams in that general catagory, but on the level of analysis that we are presently at, I think it is a fair statement.

Q Now, I believe in your evidence that you stated that the East of the Franklins Route was practically the same length as the Arctic Gas Route, and I am advised that from the Delta to Rainbow Lake the difference would be at least 60 miles and that the East of the Franklins would be 60 miles longer. Would you disagree with that?

A No, I don't think that I disagree with that. That isn't really much of a difference. It may in fact be 60 miles shorter if you take in all the twists and turns along each of the routes, but on the basis of the map, they are generally about the same length.

Q So, it is a question of

how significant you regard the difference in length? In other words if it was 60 miles you wouldn't consider that to be all that significant?

A Well, I am not saying that it is 60 miles further and, you know, I am even suggesting that too, at least at the Northwest Territories boundary, if you want to go over to Rainbow, well, that is really --I would agree, if you want to go to Rainbow and follow both routes along, and measure them to Rainbow, it would probably be a bit longer. To the Territories border it is about equal and depending on the detail of measurement along each of the, say, preliminary final design routes, East of the Franklins might even be shorter.

Q If I could now turn to your mile by mile discussion of the East of the Franklins --

THE COMMISSIONER: If you are turning to another subject, would this be a good point at which to adjourn?

MR. CARTER: It would, sir.

THE COMMISSIONER: All right, we will adjourn to --

MR. GOUDGE: 2 o'clock, sir?

THE COMMISSIONER: 2 o'clock. Oh, I was discussing our schedule in November yesterday and you will remember that I said that the week of November 10th presented difficulty because the first day, the 10th, Monday, is all right, but the second day, Tuesday the 11th is Remembrance Day and so I said

we would not sit on Monday the

I think what we ought to

8th which would give us a

November the third, then we

off, Monday the 10th, Tuesday

will recommence on Wednesday

Unless there is some violent

think that is what we will

really lose any time. I am

for that suggestion.

MR.

that when it comes to that

will adjourn until two, then.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Ready to go, Mr. Carter? You just carry on, if you will.

MR. CARTER: Very good, sir.

Q When we adjourned, Dr. Roed, I was about to get into a consideration of the east of Franklins route, referring to the Mile by Mile description that you've given in the bound report. Now, in the first section, Mile 0 to Mile 175, you point out that two of the features are, firstly that the area is well-drained and also that the terrain is lower in relief. I'm wondering about those two characteristics and whether or not it's true, it's not true in areas of continuous permafrost and particular as we're dealing with here. Terrain with low relief is generally poorly drained relative to areas of high relief.

A Yes, the answer to that question is "yes". But you know, we're talking about a comparative thing. I made the comment that it was generally of lower relief in comparison to the more rugged aspect of the terrain in the similar section of the Mackenzie Valley route. It was simply a comparison that along the Mackenzie Valley route, in that particular portion of the area we're looking at, the east of Franklins route crosses over less rugged terrain. Perhaps that's what I should have said.

Q Because as you say, if you get into low relief you could have more problems

with drainage, particularly in permafrost areas.

A Well, low relief doesn't necessarily indicate poor drainage conditions. Low relief refers to the difference between the low areas and the high areas, and if it's only 100 feet, that is considered to be low, whereas say in the Rocky Mountains where you have a relief of 7,000 feet, that is high relief. I think you're confusing -- well, perhaps --

Q I think you would understand the difference if I could refer you to the next section, Mile 175 to Mile 300. Again you refer to the feature of low relief. Is that not correct?

A That's right, but I don't necessarily refer to it as a depressional basinal areas along the route. It is simply a relative description more or less in comparison to the Mackenzie Valley route. Too mountainous an area, if you want to take the extremes. In other words, there's a gently rolling terrain with very few high hills to climb and this kind of thing.

Q Well, I understand that. In that section you refer to the route passing over the saddle of the Colville Hills.

A Yes.

Q And then in the next sentence refer to low relief, and I'm wondering if it is not fair to say that there is a considerable -- or the relief is fairly high, particularly in crossing the saddle of the Colville Hills?

A Well, I wouldn't consider that a very high area.

Q I'm advised that it's in the order of four to 500 feet, is that about the range that you'd expect?

A Over that 50-mile stretch, you know from one end to the other there could be a difference of four to 500 feet, I'm not exactly sure.

Q Well, as I understand your description of "relief", it's not so much looking at it over long-range, but the difference is in --

A That's right.

Q So that was what I was referring to, and I'm advised it's in the order of four to 500 feet, in the silty area of the Colville Hills, the saddle of the Colville Hills.

A Well, that's not my information.

Q You disagree with that?

A I would disagree with that.

Q Now, you've told us about the fluted moraine, and that it's the big advantage of the east of the Franklins route. Could you tell us how many miles you'd have to cross fluted moraine at right angles?

A I think I've indicated that there is an area between the southern fluted moraine and the northern fluted moraine where the

trend of the topography is at right angles.

Q That would be the section on your figure 1 between the two circled areas.

A That's correct. Now in all that entire area I would estimate that perhaps half of it would be in direct, directly perpendicular to some of the topographic forms. The other half you can align it along topographic forms locally.

Q We move next then, Dr. Roed, to the assessment between Mile 300 and Mile 600, and this is found on page 16 of the bound report. At the top of that page you refer to glaciolacustrine. I hope I pronounced that right, sand deposits which will allow selection of a well drained route. I am wondering what you base that view on that these deposits are well-drained?

A This is one of the areas that I looked at in a little more detail on air photographs of the area, and the features that I am referring to here are a combination of the abandoned strand lines, these old beach lines, and the silty moraine that are preserved north of the Horn Plateau, there are grooves that form low ridges, and I should say there are flutes that form low ridges and also there are ridges of deep sand. These are indicated to be very well drained because of the vegetation on them and the general terrain characteristics in the area.

Q The next section is Mile 600 to Mile 700, and -- oh, I'm sorry, before I go on-- still in the Mile 600 to Mile 400, you mentioned the pressure of karst features. Did the route as you foresee it cross any of these features?

A The corridor zone that we are representing here could cross some of these features. They are not known in any detail. I don't suppose that they offer any problem with regard to pipeline in any event, but they may offer problems for other construction purposes.

M.A. Roed
Cross-Exam by Carter

Q Now, moving onto the next section, Mile 600 to Mile 700, and specifically I refer to the ground between the Horn Plateau and the Mackenzie River. Would it be fair to say that this area is relatively poorly drained?

A From the indications that I have, the region is not as well-drained as the rest of the route.

Q And could you expect to find frozen and unfrozen ground in this area?

A I would expect that there would be a -- there could be isolated areas of permafrost yes.

Q And these could cause some problems in construction?

A I would expect so.

Q Now, again you say that there are these strand lines in this area. Does the corridor run parallel or perpendicular to these strand lines?

A Well, what exactly are you referring to, what section? Could you refer me exactly to the paragraph -- the page?

Q Again, on page 16, the second sentence is:

"Careful selection to ensure a good route, especially if strand lines can be followed."

A O.K., I'm with you now. I'm sorry. Yes, these strand lines are -- they curl right around one plateau -- that is the Horn Plateau.

It used to be an island [illegible] some of the strand lines appear [illegible] around [illegible] part-way. It would be my suggestion to follow [illegible] as closely as possible along the route.

Q So [illegible] would suggest [illegible] the pipeline take a sort of [illegible]

A A broad curve there, that is right.

Q [illegible] the S[illegible] Mile 700 to the Alberta border, is it not the case that in this area as well you find poorly drained terrain?

A I would think there would be some areas of poorly drained terrain, but I [illegible] worked in that area myself, and it looked [illegible] generally speaking. I don't think [illegible] not as much poorly drained terrain [illegible] the route as the corrolative [illegible] the Mackenzie River route.

Q [illegible] arize, what you are saying [illegible] east of the [illegible]

[illegible] problems [illegible]

A Yes.

Q Now for the east of Franklin route, you propose these staging areas and then I take it that there will be winter roads in these areas?

A That's right.

Q Would these be required to be in areas where there were no existing winter roads?

A At the moment.

Q Yes.

A Yes.

Q Now, have you taken costs into account of your assessment of routes and corridors?

A We have done a very general analysis with respect to the increased distance of transport that would be required along winter roads. That is trucking. We have not costed the trucking but we have determined the general magnitude of increased trucking costs which is the primary consideration with regard to increased logistics.

Q Now, if I could refer you, sir, to your chart with the dots on it.

THE COMMISSIONER: The exhibit?

MR. ANTHONY: Table 1

MR. CARTER: Yes, Table 1.

MR. ANTHONY: I believe the two figures and the tables were provided separately, but --

THE COMMISSIONER: Figure 2 or figure 1?

MR. ANTHONY: Table 1.

THE COMMISSIONER: Right, right.

MR. CARTER: Q The dots or the black marks depending upon how good your route is, your first category in this rating is sensitive terrain, and bearing in mind some of the considerations that I asked you about in the mile by mile routing, I wonder if you still agree with the small dots that you have given to the east of the Franklins and the edge of the Shield route, or whether they might not be given a moderately sized dot?

A No, I am sticking with this presentation as it is, and I would like to add that this graphic portrayal is an attempt to simplify the general conclusions as a result of this work.

Q Moving onto your section, "Construction problems". I ask a similar question and do so, because under the east of Franklins you've given it the small dots and as you stated, you will require these winter roads over to the Franklins route, and I was wondering if in view of that, do you still consider construction is not much of a problem on that route?

A I still do, and the reason being that these construction problems are probably related to terrain sensitivity. The terrain sensitivity is much higher in the Mackenzie River Valley than either of the two routes which is a fundamental part of my evidence. Therefore, construction problems, comparatively speaking, do not change.

Q Well sir, you've got a category on the top with "terrain sensitivities" and then you've got another category for construction problems,

and I take it that you are talking about something different than just terrain sensitivity.

A Construction problems in relation to sensitive terrain.You will note that the east of the Franklins and edge of the Shield route both have very little sensitive terrain in them, in comparison to the Mackenzie River Valley. Therefore we would expect that the construction problems would be in relative scale to that.

Q But you acknowledge that you could encounter ice content in the terrain east of the Franklins?

A Yes, I acknowledge that, but I want to stress as my opinion that you will not encounter the amount of ice and the included problems along the east of the Franklins route in the scale that that is well-documented along the Mackenzie River Valley.

Q Now, still dealing with your category of construction problems, your edge of the Shield route is given in small dots as well. I note you have a separate category for major water crossings and I take it from that in assessing construction problems on the edge of the Shield route you haven't included in that assessment the construction problems in crossing the large bodies of water.

A That's right.

Q And in the next category construction materials, the edge of the Shield is given a small dot. I am advised that particularly along the northern part of that route and again probably around the major lakes there could be a scarcity of good construction materials. Would you agree with that?

A What kind of construction materials?

Q I believe I'm talking about sand and gravel.

A There is a possibility. However, looking at the entire route, over the entire route, it's certainly clear to me that there are many more sand and gravel deposits along the entire route as compared to the Mackenzie Valley, and I think it is a possibility that you will find isolated localities where sand and gravel will be a problem; but they are comparatively few.

I might add that we did not consider bedrock as a potential aggregate source, and along all routes there is a fair representation of bedrock, if that kind of material has to be used.

Q On page 11 of your prepared evidence, you refer to the report of the Pipeline Assessment Group and the fact that they have a number of criticisms of the Arctic Gas route and I'm wondering if that's not mostly a function of the time spent evaluating it, whether or not it's quite likely that if either the routes proposed by yourself

were subjected to the same scrutiny, that they might just come up with as many points of concern.

A I think the whole point of referring to that report supports the idea of looking at alternative routes. We have with the knowledge of the sort of fundamentals that have been outlined by the Northern Pipeline Group have been able to locate a route that in many cases circumvents any concern that, as they relate it in this report.

Q There may, however, be problems perhaps as yet unforeseen though, in these routes proposed by yourself.

A Yes, there could be.

But certainly they wouldn't be of the magnitude from the standpoint of the terrain, as is already documented on the Mackenzie River Valley.

MR. CARTER: I have no further questions, thank you.

ME. GOUDGE:

Mr. Commissioner, I might begin with Dr. Roed by asking, not having been here yesterday, so I'll be certain, whether or not the five exhibits attached to this report are to be treated as evidence? I understood from this morning's exchange and a brief look at the transcript that they are not.

MR. ANTHONY: I believe, Mr. Commissioner, the appendices are part of the report and evidence before you. What is not part of the

evidence before you is environmental overview appendix "E".

MR. GOUDGE: The other four appendices are then?

MR. ANTHONY: The other four may be referred to and were prepared by Dr. Roed or under his supervision, as a background in support of some of his conclusions in the evidence he's presented in his statement.

MR. GOUDGE: Thank you.

CROSS-EXAMINATION BY MR. GOUDGE:

Q Dr. Roed, you begin your prepared testimony with a brief recitation of what I would call the principle of corridor development where you say that on page 1 of your prepared evidence:

> "That a major and far-reaching implication of any potential transportation route is that once a single facility is established for whatever reason, it is difficult if not impossible to curtail additional facilities along the same general route."

You are familiar, I take it, with the pipeline guidelines?

A Generally.

Q Yes, and I take it you'd agree with me that they assert that as a kind of principle as well; is that so?

A Yes.

Q And in fact insofar as pipeline development is concerned, they dictate it as a kind of consequence, is that so as well?

A I'm not sure. I'm really not familiar in that much detail with that document you referred to.

Q And you gave in answer to Mr. Carter this morning one or two examples of where imperically it's been so that a second, third, and so on facility has followed the route of the first. Did I understand you correctly in that?

A Yes.

Q Do you know of any cases where there has been strong objection to further facilities following the route of an initial facility, and yet further facilities have followed that first facility?

A Precisely I don't. Not, you know, except for the example that I've related with the Banff National Park.

Q Was there opposition in that case to the subsequent facilities following the route of the original facility?

A Well, there's certainly opposition to the twinning of the TransCanada Highway right now, and I'm not sure whether that has advanced to the stage of actually proceeding, regardless of the opposition or not.

Q Would you agree with me that the principle of corridor development is perhaps

a tendency rather than any kind of imperative.

A Well, I'm not sure what kind of corridor development you re talking about, but the kind of corridor development that I am talking about is one that is based upon long-range planning a complete inventory of physical biologic resources and a thorough treatment of socio-economic and environmental factors, and at that stage perhaps we would be able to choose the best corridor. That is the kind of corridor development I am talking about. If that meets your definition, then I would agree with you.

Q The principle of corridor development I refer to, though, is the tendency of further facilities to follow the route of the first facility. You'd agree with me that that tendency exists?

A Yes.

Q Would you agree with me that it is not an imperative, it is simply something that emperically has appeared to be the case?

A Yes.

Q There's nothing inherent in nature that requires further facilities to follow the routes of the first facility.

A Not necessarily.

Q It is proven to be the case in many instances. Would you agree with that?

A Would you repeat the question again. Certainly be the case that ---

Q Further facilities have tended to follow the route of the first facility in an area?

A Yes.

Q I am interested in pursuing a point raised by Mr. Carter this morning. Would you agree that the Mackenzie River itself is a transportation facility?

A Yes.

Q And that there is a telecommunications facility along the Mackenzie now?

If the corridor principle is sound, isn't it so that the first route in this area has already been chosen?

A By who?

THE COMMISSIONER: By nature.

A From the standpoint of development, I certainly acknowledge the obvious use that the Mackenzie River offers. That is something that we didn't plan. It was there to begin with. Now, what we have been, if you like, chosen to decide is whether we want to maintain that area as a major corridor. The evidence that I am presenting to you suggests that it should not be maintained as a major transportation corridor, that from the standpoint of terrain sensitivity and other resources that may occur in the north, that it is not an appropriate place to maintain or build up a corridor. We do not necessarily have to follow nature. We have the facilities to, not necessarily follow nature in this particular case.

Q Dr. Roed, you ask us to prefer either of your two easterly routes because they are preferential not just for the first facility, the gas line, but for subsequent facilities.

A That is right, yes.

Q I am suggesting to you that the first facility has been built or has been in existence along the Mackenzie Valley and if your corridor development principle is correct, it will, to quote you, be difficult if not impossible to curtail

additional facilities along that general route.

A What facility are you talking about again?

Q I am talking about subsequent transportation facilities following the initial facility, which I have put to you, in the Mackenzie Valley is the river itself.

A But that is not man-induced.

Q But you agree with me that it is a transportation facility.

A Certainly, but it is not man-induced.

Q Isn't it though in some sense misleading to make a comparison between the three corridors that you pose as if there were no initial facilities in any of the three when there is in fact an initial facility in one of the three.

A No, I don't agree. I feel that the basis of my comparison, that terrain sensitivity fundamentally, and the other features that we pointed out is a solid base on which to decide on where to put the next route.

Q But it is not a fair comparison, is it to assume that there are no facilities extant in any of the three routes.

A There certainly is no comparable natural facility that has been naturally used by activity up and down the Mackenzie Valley, that is right.

Q In only one of those three corridors, the Mackenzie Valley, does that occur, isn't that so?

A No, that is not so. We have another general area of transport that has been used quite extensively in recent years, and I am referring to the Great Bear River, for one, and secondly I am referring to what has been referred to as Denison's Ice Road, which is a series of lakes that connect Great Bear River -- or Great Bear Lake with Yellowknife.

Q Is Denison's Ice Road along or approximately along either of your two easterly corridors?

A It is approximately along the Edge of the Shield Route.

Q I see.

THE COMMISSIONER: What was the other thing you said besides Denison's Ice Road?

A The Great Bear River barge and road system, taking supplies in and out of Fort Franklin, Great Bear Lake and Echo Bay Silver Mines.

MR. GOUDGE: That is a right angle, though, sir, to the three proposed corridor routes, is it not?

A Pardon me?

Q That facility does not run along any of your three corridors, it runs at

right angles to all of them.

A That is right.

THE COMMISSIONER: What is the silver mine at Echo Bay? Is that Terra?

A No, it is Echo Bay Mines, and there is also Terra Mine, also, there are two mines there.

THE COMMISSIONER: At Echo Bay?

A Yes, well, they are very close together.

THE COMMISSIONER: And now they take the ore out by barge, do they, or how do they get it out?

A I think they fly some of it out, some highgrade material out, but the copper rich concentrates are stockpiled and are taken out by barge.

THE COMMISSIONER: In the summer.

A That is right.

THE COMMISSIONER: Do they take them north or south?

A They take them south and put them on the railroad.

THE COMMISSIONER: Onto the railway.

A Onto the railway, yes. Well, I think they do truck some out also.

MR. GOUDGE: Do they take them out along the Mackenzie Corridor, sir?

A Yes, -- well, partly, yes.

Q Now, Dr. Roed, turning if I may then to the kind of general planning techniques you have used in approaching this comparison, you give us a list, at the top of page three of your prepared evidence, certain factors that you use in your initial comparison. Are those factors an inclusive list of the factors you used to compare or were there others?

A These are the -- the list that I have suggested should be used and generally speaking I would say that we have tried to relate to this list, yes.

Q You say in column two under terrain that aesthetic potential is a factor to be used to compare. What do you mean by that?

A Well, I mean by that, the concern through my experience that landscape architects have in the planning, environmental planning of route selection, and what they like to see from my experience with them is something that blends with the terrain and vegetation patterns rather than something that is in contrast to them and that is basically what we are talking about.

We start in the beginning with the highest aesthetic potential.

Q Which I take it is land,minus development without development.

A Well, that's right, but if you're talking about a linear pipeline and you're talking about a linear fluted moraine, it's just a, you know, somewhat highly compatible combination and it would be fundamentally aesthetic.

Q If aesthetic potential then is at its highest, land without development, using that factor of comparison only, would you agree that your two easterly corridors rank ahead of the Mackenzie corridor?

A Yes.

Q There is a wilderness factor attaching at present to the two easterly routes which one cannot attach to the Mackenzie route.

A We have not considered that aspect.

Q Well, surely it's built into your aesthetic potential factor.

A No, that is not what I mean. By "aesthetic potential" I do not refer to wilderness classification.

Q I see, so you haven't used a wilderness factor in comparing these three routes?

A No, I have not.

Q But you would agree with me that if you did, the two easterly routes would rank below the Mackenzie Valley in terms of what one would develop.

A They could.

Q Well, they would, wouldn't they? They're not developed corridors, the Mackenzie corridor has some development in it.

A Well, the corridor, in general yes, but it just depends on where you place the pipeline finally in the Mackenzie Valley. It could have really no relation to existing development along there. I mean it might be, if you're talking about the river, the pipeline is quite a ways from the river in places.

Q Well, I'm talking about the Mackenzie corridor as compared to the east of the Franklin corridor as compared to the edge of the Shield corridor, and I suggest to you that if you rank those three in terms of wilderness potential, one must rank the Mackenzie corridor below the other two, and therefore more easily developed on that criteria.

A I would have to, you know, agree with that in general.

Q Yes. You say in your prepared evidence that a comparison at the early planning stage yields the three corridors you've spoken to us about. Do you have any comment on the Fairbanks corridor, using these criteria?

A Well, actually, you know,

I don't have a comment on the Fairbanks corridor. My study was restricted to the Mackenzie Valley area.

Q Then on page 11 of your prepared evidence, you say at the first full paragraph:

"While further analysis and research is required to resolve potential problems of logistics and supply it is suggested that the disadvantages would be outweighed by the other advantages of these alternative corridors."

I'm interested, sir, that that paragraph suggests some kind of trade-off process that you went through using the factors I have just referred to. Do I read that paragraph correctly?

A Taking all those factors into consideration?

Q Yes.

A Yes.

Q Could you give us some assistance as to how you went about the trade-off process? Was it intuitive? Did you quantify?

A Well, if I can just relate to you, going back to this diagram in Table 1, you know, that's basically, it's the synthesis of that table.

Q Well, let me put it to you this way: How did you decide to put a big black ball under the Mackenzie Valley column for sensitive terrain, and small black balls beside the other two?

A Well, very simple because the Mackenzie Valley contains more sensitive terrain

than the other two routes.

Q So you really have three categories.

A Yes.

Q Good, moderate, and bad, or whatever.

A More or less, yes.

This is just strictly a general comparison.

Q And then I take it what you do in order to give the prize to the two easterly corridors is to count up the number of big black balls and give the prize to the fewest number.

A You could do that, yes.

Q Was that the way you did it?

A I hadn't counted them up and given them a weight. But perhaps I should, sometime.

Q Was there any other process you went through to determine that the two easterly corridors are preferable?

A No, there wasn't, not from a --

Q I take it that from terms of these factors appearing on Table 1 you gave each of them equal weight.

A Yes.

Q Now sir, coming to the two corridors that you spoke about in most detail for

us, dealing first with the edge of the Shield route, are you familiar with Dr. Rampton's report for the Environmental Social Program called "Terrain Evaluation, Mackenzie Transportation Corridor, Northern Part"?

A Yes.

MR. GOUDGE: Mr. Commissioner, it would be useful, I think, for all of us if this were filed as an exhibit. Dr. Rampton isn't a witness but I think that is not pertinent. It's a report that is here and is available to all.

THE COMMISSIONER: Well it will be marked as an exhibit.

(REPORT OF DR. RAMPTON "TERRAIN EVALUATION, MACKENZIE TRANSPORTATION CORRIDOR," MARKED EXHIBIT 300)

MR. GOUDGE: Q In those three areas dealing with the edge of the Shield route, Dr. Roed, I wasn't sure from your answers this morning whether you have any opinion on how the water crossings on that route would likely be made by ship laying from barge, laying off the ice, do you have any opinion as to that?

A Generally I am not a marine engineer nor am I a pipeline engineer, and -- but it would seem to me that the simplest way to lay that pipe would be to lay it off the ice.

Q I see. You simply say, I take it, because under-water pipe has in the past been laid by each of those three methods, that it could be laid in this case.

A Well, the idea is taken from Polar Gas research group right now, and I'm not aware of whether the pipe has actually been -- this has actually been done. I understand from Polar Gas Reports that this is the way they intend to go about it.

Q You'd anticipate that they would have concern about ice thickness supporting their pipe-laying machinery?

A Yes.

Q And presumably you would have some concerns about ice thickness on these two major lakes for the same purpose.

A I would think so, yes.

Q I take it, though, you have no doubt that the ice thickness would be sufficient to support pipe-laying machinery?

A Not at this stage, but it would be a factor that would have to be --

Q It's a possibility.

A Yes,

Q Now, dealing with the logistical difficulties that your easterly route, even the east of the Franklin route raises, you suggest initially three supply points, as I understood you.

A Basically, yes.

Q Three major staging points. I take it from a mathematical calculation that that would mean each major staging point would supply up to roughly 400 miles of the length of the route.

A Well, --

Q The one in the middle supplying one --

A Yes.

Q -- 200-mile stretch, in either direction for example.

A Yes, I don't think it's 400 miles. I think the route is less than --

Q If you say it's 800 miles from top to bottom, then the middle point of supply is 400 miles or 300 miles.

A O.K., 200 miles each way, that's right, that's correct.

Q Now that means that you're talking about three or four construction spreads, if a spread deals with say 50 or 75 miles.

A Yes.

Q I suggest to you that you'd need a large number of staging points, many more than three to properly supply the line. Would you agree with that?

A No, I don't think I would agree with that.

Q That isn't your field of expertise in any event though, is it?

A Well, I think it's a logical kind of appraisal, I think that it could be done, I don't think you need particular expertise to comment on something like that.

Q Would you agree that if more supply points were necessary, that there would be

a concomitant increase in the number of access roads required to the east of Franklin corridor?

A I do not foresee any access roads except up the Rory Lake Valley.

Q Well, come with me so far as to make an assumption that more than three supply points are necessary on the Mackenzie, and assume they are. Isn't it so that each supply point must have a supply line into the east of Franklin corridor?

A They'll be located pretty well right on the corridor. There will not be any additional -- in fact in many cases there will be less access road required along east of the Franklins as there is presently proposed in the Mackenzie River Valley. Now I'm not talking about the access road along the route itself.

Q I'm not sure I understand you, sir, and let me try to approach it this way. You've named three staging areas. One near Fort Providence, one on the Great Bear River, and one at Inuvik.

A Yes.

Q If more supply points are necessary, would they not be supply points with, perhaps we've got a semantic problem, with locations on the Mackenzie River from which equipment and machinery could be transported to east of the Franklin corridor?

A If more are required, yes, that's correct.

Q Yes, and if more are

required, the increase in numbers of access roads is going to increase the environmental impact caused by construction on east of the Franklin corridor.

A Yes.

Q Now, sir, you say one of the advantages of your -- well, before I pass to that, the same is true, is it not, of the edge of the Shield route?

A Yes.

Q Now, one of the advantages you speak of for the edge of the Shield route is that it will provide a corridor accessible to mineral material in the Shield, is that so?

A That is a possibility, yes.

Q I take it it's so, though, that the mineral material in the Shield is in the main likely to be found a good deal east of the edge of the Shield corridor, within the Shield itself.

A Well, not necessarily. I think there is lots of potential all around the edge of the Shield in a200-mile band, if you like.

Q But within the Shield rather than along the edge.

A Oh yes, it's within the Shield.

Q Yes.

A As far as base minerals are concerned, yes.

Q So that any facility designed to haul out that material would be some distance at least to the east of a pipeline along the edge of the Shield.

A That's correct, yes.

Q Now sir, you spoke about another advantage of the edge of the Shield route, namely, its location -- near its northern terminus, if I can put it that way, related to the potential gas deposits, and I would like a reiteration from you, sir, of the report that you used to base that opinion on. The opinion I'm speaking of is the location of the potential gas-bearing body. You mentioned a report this morning.

A Yes, and this is a report that was done in-house by the Northern Assessment Group by Mr. Jim Shear who evaluated generally, not specifically fo r this evidence, that I had access to.

MR. GOUDGE: Sir, I wonder if Mr. Anthony might give us that report?

MR. ANTHONY: Mr. Commissioner, I checked on that and I understand that that is not a completed report, but the aspects of it related to the identification of the sedimentary basin had been completed and was provided to Dr. Roed, and so there's a portion of it has been provided. The report is being completed and will be tabled as a report of this Inquiry, for the Northern Assessment Group available to this Inquiry.

THE COMMISSIONER: The reporter

advises me she has to change her tape, so maybe we could stop for coffee now.

MR. GOUDGE: Yes sir.

THE COMMISSIONER: And come back in a few minutes.

(PROCEEDINGS ADJOURNED FOR FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: I think that Mr. Goudge has some further questions?

MR. GOUDGE: Yes. Just a few more, if I may, Dr. Roed.

Q Turning really finally to the East of the Franklins Route that you were speaking about, you drew a contrast, as I understood you there, between the terrain characteristics of that corridor and the Mackenzie corridor, and let me see if I understand the highlights of the difference you drew. I take it you see a difference in the amount of ice-rich glacial lake silts that there are in each of the two routes?

A Yes,

Q And I take it that the large number of deep valleys in the Mackenzie Route give you some concern as well?

A Yes.

Q Is it fair to say that those are the two major factors, at least in the Mackenzie Route that cause you concern? -- the large amount of ice-rich glacial lake silts and the relatively large number of deep valleys?

A Yes.

Q Now, the East of the Franklin Route on the other hand, I think, you say, is a long belt of narrow ridges of till, basically.

A Yes.

Q And I think it is your

hope that the pipeline could be built on the tops of those ridges?

A Yes.

Q And you feel that the tops of those ridges would presumably prove relatively less troublesome?

A That is right.

Q And would avoid a number of stream crossings that occur in the Mackenzie corridor.

A Yes.

Q Now, let me make a comparison for you between the Mackenzie and the East of Franklin Routes and deal first with the Mackenzie Route. Would you agree that insofar as we talk about deep river valleys, the major area of concern runs from, say, the Willowlake River in the south to the Thunder River inthe North?

A Yes.

Q And insofar as we worry about ice-rich silts on the pipeline route in the Mackenzie, the major area of concern at least runs from River Between Two Mountains on the south to the Gibson Pass on the north?

A Yes.

Q There may be one or two other areas of concern, for example, the area between Fort Good Hope and Thunder River further north and the area in the vicinity of the Mackenzie River Crossing upstream from Fort Simpson at the south.

A That is right.

Q The major area of ice-rich silts is the area between River Between Two Mountains and the Gibson Pass.

A Yes.

Q Now, let me switch over to the East of the Franklin Route and ask you whether or not the area of fluting, which you spoke about, that provides the best pipeline building route is not the area from, say, the northwest corner of Great Bear Lake down through at least part of the area you called the southern area of fluted moraine.

A Yes, I think so, yes, if I understand the question.

Q Well, put it this way. You say as I understand you, that the southern area of fluted moraine on the East of the Franklin Route is very good for pipeline construction.

A Yes.

Q And it is very good because of these long flutes that you spoke of that may run up to a hundred miles.

A Yes.

Q Now, where do you place the southern limit of that very good pipeline building land?

A Approximately at the northern flank of the Horn Mountains, the Horn Plateau.

Q Is that what you attempt to indicate by the southern boundary of the south

circle --

A Yes.

Q -- on exhibit one, or table one, the attached figure one attached to your evidence?

A Yes.

Q Let me suggest to you that the southern limit of the very good land may be rather further north than that and that there are in fact some east-west flutings that cause concern in the area, for example of the Willowlake River depression.

A The southern portion of that area is a little more difficult than the rest of it, and so I looked at that in a little more detail and I was convinced, myself, that a line could be chosen through that slightly more difficult area that would be entirely compatible with the characteristics of the East of the Franklin Route.

Q You would go with me at least this far, though, that the southern area of your southern circle on figure one is more difficult than the northern part of the southern circle on figure one?

A It may not be, but it could be.

Q Could I ask you to go to the Glacial Map of Canada, if you would. I looked at it at the break.

Now, sir, could you point out

roughly where the northern edge of the Willowlake River depression is on your East of the Franklin Corridor?

A Yes, I think it is this area that you are referring to, right in here. Is that correct? Do you want my magnifying glass?

Q Let me point out to you, sir, what appears to me, at least, to be east-west fluting on the East of Franklin Route that would run approximately from the north edge of the Willowlake River depression.

A They are shown distinctly on the Glacial Map of Canada and I don't argue that, but if you take a look at the ERTS photographs here, you will see that there is a very short area here, where the terrain does have the east-west trending features.

The route that I envisage here, it comes right around here and follows this fluted moraine and strand-lines and this is the difficult area that we would have to take a close look at and to jump over to these flutes here. So there is a very small area in that where it does go across some of these east-west terrain features.

Q Let me suggest to you, sir, that the southern limits of the good north-south flutes ceases at about the north edge of the Willow lake River depression as shown even on the ERTS photograph, do you agree with that?

A No, I don't think that I

could agree with that because we have done some work in here and I think with further detail that a route that is either following strand-lines or these subdued fluted moraine features can be chosen, but I would agree that the features are more subdued in that area.

Q Well, let me ask you to focus, sir, on the part of your corridor south of the Willowlake River depression, down, say, to Fort Providence and ask you to compare that to the corresponding portion of the Mackenzie Corridor and ask you whether you agree with me that the superiority of your route in that segment is less pronounced than the superiority of your route in the segment immediately north.

A At the level of the work that we have done, I'm afraid I just can't comment on that.

Q You aren't prepared to agree or disagree?

A That's right.

Q You've no doubt though thatthe superiority of your route in the area immediately north of the Willowlake River depression is substantial over the Mackenzie Valley corridor in the same latitude.

A Yes.

Q Now let me take you to a comparison of the two corridors further north, at the north end. I took it from your answers this morning particularly to Mr. Carter, that you agree with the general proposition that as you go further north into the continuous permafrost area your chances of getting ice-rich soil, even in till, increase substantially.

A Yes.

Q I take it from that that you would anticipate some ice problems, some ground ice problems, even in your east of the Franklin route at the north.

A Yes.

Q And would you agree then that a comparison of the northern segments of the two corridors does not yield a marked superiority to the east of the Franklin corridor?

A Yes.

Q I come back then and ask you to agree with me that the major area of superiority of your east of the Franklin corridor to the Mackenzie corridor is the southern area of fluted moraine.

A I would agree with that, yes.

Q Dr. Roed, Dr. Rutter yesterday enlightened us with his east of the Franklin route. Would you agree that it takes in the area of most advantageous superiority?

A No, it doesn't.

Q Because it's further west?

A Because it's further west and the flutes in that area are short and discontinuous in comparison to the flutes in the southern belt that I've outlined here.

Q The flutes in both your routes, both his and yours, in that area run north-south, no doubt about that?

A Pardon?

Q The flutes in both routes yours and his, in this middle part of the route, run north-south.

A I believe so. I believe so.

Q Can I describe it this way, that both you and Dr. Rutter, at least in the middle Mackenzie section of your routes, are talking about parallel zones of fluted moraine?

A Yes, they appear to be.

Q Would you advise that there is any gain to be made by examining not simply two distinct corridors as you propose, but a variety of route s which may in every case take account of this middle section east of the Franklins?

A Yes, I think that would be advantageous except that on the level of work that we have done, we feel that we have identified the most suitable alternate routes.

Q There is no need, however, to build along your entire corridor to take advantage of the area in which you say there is the most marked superiority?

A No, if you're talking about some combinations, especially in the northern end of the route, yes, I agree with that.

Q Or the southern end.

A It would depend on, you know, an analysis. I would certainly have a wide open mind in that respect.

Q Yes, your most strongly held position is to depart from the proposed Mackenzie Valley route in its mid-section so to speak.

A That is the most strongly presented area from the standpoint of terrain sensitivity.

THE COMMISSIONER: From the standpoint of what?

A Terrain sensitivity.

MR. GOUDGE: Q It's in the area roughly from the north-west corner of Great Bear

Lake to the Willowlake River depression that you see the biggest superiority for the east of the Franklin route.

A Major superiority, yes.

MR. GOUDGE: Thank you, sir. Those are all the questions I have.

THE COMMISSIONER: All right. Any re-examination, Mr. Anthony?

MR. ANTHONY: No re-examination, Mr. Commissioner.

(WITNESS ASIDE)

MR. ANTHONY: I wonder if we may have your indulgence and the indulgence of others here for a few moments, if we propose to proceed onto new matters, in that Dr. Rutter and Roed will be able to catch the plane, I was wondering if they could have just a moment so they could take the maps down and file them away so that they can catch the 5:30 plane?

THE COMMISSIONER: Certainly. It's not possible to leae the maps with us, I'm thinking about that map on the far left, so is there a problem here? If they've been marked as exhibits we don't mind releasing them into the custody of Drs. Rutter and Roed, but we should really make some arrangements to get them back or to prepare copies for them, whatever suits all of you.

MR. ANTHONY: Well, I'm not sure whether these are being used presently or not.

MR. ROED: Well, there is

another set ERTS mosaics and you're certainly welcome to have this set if it is in any way --

THE COMMISSIONER: Well, could you leave the whole batch with us? I think one is ours anyway.

MR. ROED: Yes, but I think it's not this one. But you can have this one.

THE COMMISSIONER: Oh, I see.

MR. ROED: I have no objection to that at all.

MR. ANTHONY: If they aren't being used they can all be left here, and if necessary we can make arrangements --

THE COMMISSIONER: Why don't you just leave them on the wall then for now and they will be marked as exhibits?

MR. ANTHONY: FINE. That w[illegible] conclude their evidence then, sir.

THE COMMISSIONER: Well, thank you very much, Dr. Roed. We certainly appreciate your taking the trouble to acquaint us with the work you've done in defining these two alternative, alternate routes to the proposed gas pipeline. I should say for your benefit and that of Dr. Rutter that while you know that we did consider alternate routes at some length in Whitehorse, last August, and we were considering the evidence of Commissioner Parker and Dr. Weedon from Alaska earlier this week. We are expecting counsel for Foothills in due course, and other counsel to make further representations based on what all of you

have told us about alternate routes and when counsel have decided what they wish to say on this subject, we will be in a position to -- at least I will be in a position to consider the further course of the Inquiry in relation to these alternate routes. I think it is a question of giving some consideration to those routes, if any, that the Inquiry should give further consideration to at this stage. In any event, it has been most useful and at the very least it provides us with a backdrop against which to consider the proposed Mackenzie Valley line, and more than that, it gives us an opportunity to consider these alternate routes. I say this for your benefit, Dr. Roed and Dr. Rutter's benefit so that you will understand what our next step is in considering these alternate routes.

So thank you very much, sir.

MR. ROED: Thank you very much.

MR. GOUDGE: Mr. Commissioner, it will serve the continuity of the Inquiry perfectly for those remarks to have been made, because Mr. Hollingworth advised me at the break that he has some remarks to address to you, sir, on this very question, to put the Foothills position. Perhaps, since it can be done quite shortly, he might do that now, with your permission.

MR. HOLLINGWORTH: Thank you, sir. This may or may not be a contentious issue, but this is the statement of Foothills.

It is Foothills' opinion that it has already complied with the requirements of the

Inquiry in respect to both alternate corridors and alternate routes. Foothills takes this position on the following grounds: In the expanded guidelines on page 9, the government recites that it is prepared to receive applications to construct within broad corridors, one of which is along the Mackenzie Valley region in a broad sense. The Foothills application is for authority to construct within that broad corridor.

There does not seem to be any other reference to corridors other than on page 9, and so it is Foothills conclusion that there is no requirement to put forward alternate corridors, using the word "corridor" in the broad sense used in the guidelines. There is reference on page 11, to "alternative pipeline routes".

THE COMMISSIONER: Excuse me, would you repeat that thought?

MR. HOLLINGWORTH: Yes sir, in fact I can provide you with a copy of this statement.

THE COMMISSIONER: Oh, good.

MR. HOLLINGWORTH: It's not a very good copy, but I think it will serve the purpose.

THE COMMISSIONER: All right. A one-page document, that's a unique event in this Inquiry. Where --

M R. HOLLINGWORTH: It was the third paragraph which I just read, sir.

THE COMMISSIONER: Let me just read that.

MR. HOLLINGWORTH: Yes.

THE COMMISSIONER: Yes, all right, carry on.

MR. HOLLINGWORTH: Continuing then there is a reference on page eleven to alternative pipeline routes. Foothills understands the reference to mean alternative locations within a chosen or designated corridor. With specific reference to the Foothills application the obligation then is to consider under (iii) other pipeline routes within the Mackenzie Valley Region, the corridor defined on page 9 of the expaned guidelines.

Other locations considered by Foothills or its sponsor Alberta Gas Trunk Line have been dealt with earlier in the Inquiry. Alberta Gas Trunk Line was a member of the study group when it considered a route west of the Mackenzie River and then for the reasons given by Arctic Gas witnesses, changed to the -- that should be east of the Mackenzie route.

That evidence which included -

THE COMMISSIONER: Fast what?

MR. HOLLINGWORTH: That should read "east" rather than "cost", sir.

THE COMMISSIONER: Then changed to the --?

MR. HOLLINGWORTH: East of the Mackenzie route.

That evidence which included the reasons for the change is as applicable to Foothills as it is to Arctic Gas.

Secondly, the Foothills location panel testified as to the many miles of route where the Foothills location differs from that of Arctic Gas having considered and rejected part of the Arctic Gas Route, those rejected segments might be considered alternate to the Foothills route.

As Arctic Gas has led evidence on its route, there seemed little point to Foothills attempting to duplicate it merely to go through the motions of satisfying paragraph (iii) of the expanded guidelines.

For these reasons it is Foothills' submission that evidence relating to alternatives to the Foothills route with the broad Mackenzie Valley corridor is already before the Inquiry.

Lastly, it is perhaps worth recalling that the Minister directed the Commissioner to hear evidence relating to the difference between the Foothills proposal and the Arctic Gas proposal. It may well be in the light of that direction that although Foothills may be required to go into the question of alternative routes in more detail in some other form, the Minister intended that it would not be necessary in this Inquiry for Foothills to go any further in respect to alternatives than Arctic Gas has already done.

It is all of that reasoning that has led Foothills to the position not to lead any more evidence on alternatives than that which [illegible]

already been given.

THE COMISSIONER: I would be inclined, Mr. Hollingworth, subject to what counsel may say, to agree with you that Foothills has indeed complied with the guidelines. What concerns me is a larger question and I address it to all counsel.

At the end of the Inquiry we will be faced, counsel in making their submissions, and then I in making my report, with the necessity of making some assessment of the alternate routes.

MR. HOLLINGWORTH: Excuse me, sir, may I interject?

THE COMMISSIONER: Yes.

MR. HOLLINGWORTH: Do you mean when you say alternate routes, the Fairbanks Corridor and Fort Yukon Corridor when you make that comment?

THE COMMISSIONER: Yes. I am throwing these thoughts out for counsel to consider and at some later stage you can discuss it at a meeting of counsel and decide whether you want to say anything about it. If you don't that is all right with me. It may be that we have gone as far as we should in the consideration of alternate corridors. The impact on the north, if an alternate corridor were utilized, might be very much greater or very much less than the impact on the north if a pipeline were built along the Mackenzie Valley Corridor. It may be that some reference to those alternate corridors should be made in my report. I want you

people to think about this and make submissions on that question to me in due course.

If that is so, have we gone as far as we ought to in the consideration of the subject? Do counsel -- and this has nothing to do with whether Arctic Gas or Foothills has complied with the guidelines, it seems to me they have, and have gone as far as we can expect them to do, at this stage -- but the question that you all should consider is whether there is anything to be gained by giving any further consideration to any of the alternate corridors. I address that to you, Mr. Hollingworth, on behalf of Foothills, because Mr. Gibbs and you, acting on behalf of Foothills, have on many occasions sought to demonstrate that the gas from Prudhoe Bay in Alaska can be taken out by the Fairbanks Corridor. If that were to be done it would no doubt enhance the likelihood of the all-Canadian delivery system being adopted that you, on behalf of Foothills have urged.

Now, I thought that if you -- I thought that Foothills would tell the Inquiry at some stage, you see, you asked me to make an order that Arctic Gas provide the segmented cost comparison as between the Mackenzie Valley line and the Fairbanks line. Now, you tell me today that you have gone as far as you feel you are obliged to do under the expanded guidelines. I agree, I think you have. I thought that you were going to tell me something about whether you thought the Inquiry

should pursue the Fairbanks route any further and I thought that other counsel would tell me whether they felt the Inquiry should pursue the Fairbanks route or any other route any further.

Now, I am not asking any of you to decide what you want to say about this now, but to think about it. It seems to me that if the Inquiry were to seek to go further into the suitability of any of these alternate routes we would be confronted with a very serious question relating to the whole course of the Inquiry.

I think we have gone as far as we are obliged to go under the Inquiry's terms of reference and under the expanded guidelines. What I want to know from counsel is whether counsel take the position that the consideration so far of these alternate routes has brought us to a stage where we should examine any one of the alternates, or more than one of the alternates, in greater detail than we have. I don't think the Inquiry has any obligation, at this stage, to do so under its terms of reference. It may be that we ought not to do so. I am simply concerned that counsel should address themselves to that question, that is, think about it, consider it at a meeting of counsel, if you wish, and certainly, each one of you is free to tell me where you think we ought to go with respect to those alternate routes.

Maybe we have gone as far as we can be expected to go as far as we usefully can go, because there are limits to what you can do in

an Inquiry, constraints of time and so on .

Well, I hope that I am making myself reasonably clear.

MR. GOUDGE: Sir, if I might offer this one comment. It seems to me, respectfully, as if there are two issues. The first, raised by Mr. Hollingworth, directly concerns whether or not Foothills has complied with the guidelines, tabling the statement that they have tabled today, simply in order to preserve it. I may say that my lack of reaction is not to be taken as an indication of approval, but they have, we may wish to take the position on consideration that they have not. I trust other counsel will adopt the same sort of look at it and react attitude.

As to the second question which is of importance for the entire Inquiry as well as any one participant, I suggest, sir, that we list that to be discussed at the next meeting of counsel to be held when we reconvene in order to canvass every individual 's position as to whether they wish to call further evidence on an y of these alternate routes because, as you say, sir, if that is the case, and they do wish to call further evidence on any of these other routes, there may be first objections by any one of the individual participants, and secondly it may in any event be an input that ought to be had in determining where we go from here.

THE COMMISSIONER: Let me just say this so Mr. Gibbs and you can consider it, Mr. Hollingworth.' You persuaded me to make an order that there would be a segmented cost comparison between Fairbanks and Mackenzie Valley, and I'm not discounting these other alternate routes that have been discussed.

Now, if because the point that Drs. Rutter and Roed have made, is a point that still remains to be considered, even if you adopt the Fairbanks route for taking out Prudhoe Bay gas, you got me to make that order. I made it. Arctic Gas has complied. We now have a segmented cost breakdown comparing Fairbanks, the Fairbanks route to the Mackenzie Valley route. Having obtained it, does Foothills say, "All right, we've seen the figures, it is clear that Arctic Gas is right as they insisted when we heard their evidence at Whitehorse, and that the Fairbanks route is not a practical route for the delivery of Prudhoe Bay gas because the constraints of costs are so very much greater than in the case of the Mackenzie Valley Route", or does Foothills wish to say, having obtained that evidence pursuant to my order, "We think there should be a further examination of this route"?

Now maybe you have nothing to say. I'm not asking you to do so, but I must say that I was sort of suspended in mid-air waiting for the other shoe to drop and you didn't drop it today.

MR. HOLLINGWORTH: Well, sir, I do want to get instructions on this, but my preliminary remarks would be this, and I would like to distinguish

between the position whether Foothills ought to advance evidence of its own, and what Foothills chooses to do, subject to your consent, on the basis of representations by counsel, what Foothills chooses to do with the representations made by Arctic Gas. I think there is a difference there.

I'm certainly not stating in this statement that we're going to take the figures that Arctic Gas left with us and do nothing further with them. In fact it's our desire to cross-examine Mr. Dau on those figures.

THE COMMISSIONER: Yes, in fact he was to be cross-examined last week.

MR. HOLLINGWORTH: That's correct. As far as presenting evidence of alternate corridors, Foothills takes the position that the expanded guidelines don't call for that, that they call for a discussion on the routes within a corridor on which the government is prepared to receive applications. Now the fact that Arctic Gas has chosen to present evidence on alternate corridors is neither here nor there with respect to Foothills' evidence in chief, I respectfully submit.

THE COMMISSIONER: Well yes, I think you have complied with the guidelines. I am not asking you to do anything, let alone requiring you to do anything, except to tell me where you stand on the Fairbanks corridor on the evidence that was adduced. You don't have to tell me now.

MR. HOLLINGWORTH: My feeling

is, and I may be completely wrong on this after I receive instructions, but my feeling is that we do want to do something with the figures that have been provided to us by Mr. Marshall, but I don't believe that we plan to call rebuttal evidence, if that's what you have in mind, to say that the Fairbanks route is much to be preferred.

THE COMMISSIONER: No.

MR. HOLLINGWORTH: I don't expect that, and my preliminary feeling on that would be that it would be completely outside the terms of reference.

THE COMMISSIONER: Well, that's my concern and that's why I wanted you to --

MR. HOLLINGWORTH: But I will certainly put my mind to this and discuss it with Mr. Gibbs.

THE COMMISSIONER: I think we have reached the borders of the Inquiry and I am anxious to know whether anyone wanted to stick their big toe across the line, and Foothills looked as if they were ready to, and -- well, that's fine. I think it's important that we enter this and that you give it some thought.

Well, thank you again, Dr. Roed. I have a horrible feeling this isn't the end of the afternoon's evidence.

MR. GOUDGE: Mr. Commissioner, I was about to say we have one more item on our agenda for this week, and if we could prevail for another hour

and a half or two hours, I think it would be possible to complete that today. I'm in your hands though, sir.

THE COMMISSIONER: Well, all right, let's start, but I give you fair warning this is the third week in a row that I've been sitting and to be fair to everybody I don't want to be trying to assimilate things when I'm no longer able to. But let's start and see how far we get, and if we don't make any headway we'll have to come back tomorrow.

The next item on the agenda would then be Mr. Carter leading the evidence in chief of Arctic Gas' first panel in Phase 2-3.

MR. CARTER: We have finally arrived at Phase 2.

THE COMMISSIONER: Well, make it snappy then. I've only got until Christmas. Well go ahead, we're late in the day. I was thinking of a cartoon that appeared six months ago.

MR. CARTER: We wasted a bit of time with Mr. Hollingworth. I think his worry is that he might have to change the name of his company, if he got away from the Foothills or something.

THE COMMISSIONER: That's a devastating remark.

MR. CARTER: The first panel, sir, is made up of a number of witnesses but the evidence in chief I propose to have read in by Miss Gretchin Minning. She has been sworn, if I could just briefly review her resume.

MISS GRETCHIN MINNING, sworn:

DIRECT EXAMINATION BY MR. CARTER:

Q Miss Minning, you are present a senior staff geologist with Northern Engineering Services?

A Yes.

Q And with respect to your education, you received a B.Sc. in geology from Lawrence University, Wisconsin, in 1965.

A That's correct.

Q And your Masters in geology from the University of Washington in 1967.

A That's correct.

Q And you're a member of the Geological Association of Canada, the Association of Professional Engineers, Geologists & Geophysicists of Alberta.

A That is correct.

Q From 1967 to 1973 you were a scientific officer in the Terrain Sciences Division of the Geological Survey of Canada.

A That's correct.

Q And in 1973 you joined N.E.S.

A That's correct.

Q And your publications are listed in an appendix.

A That's correct.

Q Your responsibilities with Northern Engineering relate to the geological

aspects of the terrain crossed by the proposed pipeline.

A That's correct.

Q Now, if we could begin with the evidence, I'd ask you, Miss Minning, to indicate while going through the evidence which of the witnesses the evidence relates to, and this will be helpful for my friends in cross-examination.

A The title:

"The Impact of the Pipeline and Mackenzie Corridor Development of the Physical Environment."

First heading, "Terrain". This section will be led by R.A. Hemstock. First comments, general:

The soil, bedrock, and surface conditions along the proposed pipeline route are highly variable but nevertheless classifiable into a number of discrete terrain units. Although terrain typing provides useful general information on the physical and engineering properites of the surficial materials on the proposed route, this information is necessarily subject to the range of variability inherent within each terrain unit. For this reason, Arctic Gas does not propose to use terrain typing alone but to use terrain typing in conjunction with on-site examination, extensive drilling and sub-soil sampling, and consideration of environmental factors in the development and application of final geotechnical and other pipeline-related designs.

Most of the area traversed by the proposed pipeline route has been glaciated except

for a small area in the mountainous region of the interior alternative route and west of the Firth River on the coastal route. The glaciated areas are characterized by a variety of soils including till, glaciolacustrine silts and sands,and glaciofluvial sands, silts and gravel.

The organic content of the surficial materials varies markedly along the route. This is due largely to the differences in drainage and climate.

Ground ice content in the surficial materials is also highly variable and is dependent largely on the texture of the material and climate. Along the Coastal Plain and in the Mackenzie Delta, ground ice may comprise more than 50 percent by volume of the upper 15 feet. In its grosser forms, the ice occurs within the soil matrix as predominately horizontal, very thin to thick, as thin reticulate ice veins, and as vertically-oriented ice wedge polygons. In the same areas, dry soils - especially coarser-grained ones - may have negligible ground ice content.

In general, permafrost is continuous along the proposed coastal and interior routes north and west of Fort MacPherson. To the south in the discontinuous permafrost zone, permafrost and non-permafrost areas are intermingled. On the proposed route, the first extensive patches of unfrozen ground occur in the vicinity of Fort Good Hope. The ratio of non-permafrost to permafrost terrain increases from north to south. The coarser-textured, better-drained and exposed sites are often unfrozen to substantial depths, whereas the finer-grained soils which commonly underlie the flatter and wetter ground with a thicker organic cover are frozen at shallow depths throughout the year. North of Wrigley, permafrost terrain is generally dominant. At about the 60th parallel, permafrost is largely limited to patches.

Because of the inherent variability in soil, climatic and permafrost conditions along the proposed route, the impact of the Arctic Gas pipeline on the physical environment will also be variable and dependent on specific site conditions. For instance, the impact of a chilled pipeline on the physical environment will depend on whether the ground is frozen or unfrozen, and if it is frozen on the ice content. If the ground if frozen, the potential for frost heaving due to operation of the chilled pipeline will be low whereas the potential for thaw settlement following clearing of the right-of-way or surface disturbance may be high. If the ground is unfrozen, the potential for frost heave under certain conditions may be high whereas the potential for thaw settlement will be nil.

Subheading two: Permanent and Temporary Land Requirements. To facilitate the construction of the pipeline and ancillary facilities, Arctic Gas has applied in general for a 120 foot right-of-way for the 1150 miles of pipeline within the Yukon and Northwest Territories, the right-of-way itself would require about 17,250 acres of 27 square miles. This includes the requirement for additional land at major river crossings.

In addition to the land required for the pipeline right-of-way, approximately 273 acres or 0.4 square miles, within the Yukon and Northwest Territories will be required for construction of compressor stations, 971 acres or 2.9 square miles,

for the construction of 66.5 miles of permanent project roads, 2410 acres or 0.8 square miles for construction of airstrips and 185 acres or 0.3 square miles for wharfs.

In total, the estimated permanent land requirement is 21,109 acres or approximately 33 square miles within the Yukon and Northwest Territories.

The temporary land requirements within the Yukon and Northwest Territories include 3920 acres or 6.1 square miles, for borrow pits; 297 acres or 0.5 square miles, for material stock pile sites; and 1195 acres or 1.9 square miles for the construction of 238 miles of temporary access roads. The total temporary land requirement is 5412 acres or approximately 8.5 square miles.

The foregoing estimates of the tempoary and permanent land requirements include the East of Fort Simpson route relocation, but not the possible Cross Delta alternative currently under consideration by Canadian Arctic Gas.

Subsection three, Borrow Requirements. I will be the preson speaking to this section. The major requirements for borrow materials will be in the construction of pipeline facilities which include permanent access roads, airstrips, and compressor station pads. Lesser quantities of borrow will also be required for the construction of drainage and erosion control measures, for slope stabilization, and for the construction of a surcharge

berm over a selected portions of the pipeline ditch for control of frost heaving. The quality of grade or borrow material needed will vary depending upon the specific application. For example, coarse granular material may be required for the construction of certain drainage and erosion control measures while the main requirements for borrow for the surcharge berm are that it provide weight and that it is stable in the thawed or unfrozen condition.

In total, approximately 30 million cubic yards of borrow material are estimated to be needed for all construction requirements for the Canadian segment of the pipeline north of the 60th parallel. Borrow requirements for Operations and Maintenance are included in these figures.

The location of preferred and alternate borrow sources are shown on the pipeline route maps contained in Section 13.a.2 of the Application. Current estimates show 26 borrow sites will be required on the pipeline segment between the Alaska/Yukon border and the Travaillant Lake Junction. A requirement is estimated for about 72 borrow pits on the pipeline segment between Richards Island and the Alberta/Northwest Territories border.

The majority of the borrow pits will be developed and worked in the winter season. Most of the access roads connecting the borrow pits with haul destinations willbe winter or snow roads. Borrow pits which will be used during all seasons will have permanent access roads.

There will be a slide presentation at this point.

Point four, Mitigative Measures and this will be spoken to by G.L. Williams. Arctic Gas has attempted insofar as possible to minimize the impact on the physical and living environment by:

1) judicious route selection and avoidance, where practical of potentially sensitive permafrost and terrain;
2) development of Arctic construction techniques to minimize terrain disturbance;
3) development of a chilled pipeline system;
4) restoration and revegetation; and,
5) incorporation into the pipeline system design measures for drainage and erosion contol, and for slope stabilization.

Section 4.1, called Route Selection. The route selection and refinement criteria have been considered in detail as part of --

THE COMMISSIONER: This is something that Mr. Williams will speak to ?

A This is right, this will be an expansion of point one of those things that I just read to you.

The route selection and refinement criteria have been considered in detail as part of Phase I. Arctic Gas has undertaken and is continuing to undertake studies aimed at route refinement and improvement in the overall pipeline design. Arctic Gas recognizes that as the result of detailed site investigations and drilling which form

part of final design, further changes in the route may be indicated for environmental or geotechnical reasons; however, it is anticipated further changes in the proposed route will be relatively minor.

4.2) Arctic Construction. Arctic construction techniques have been described by the construction panel and will not be discussed in detail here. They would include such measures as the use of fill rather than cutting to achieve grade, use of snow roads and hand clearing.

4.3) Chilled Pipeline. Once in operation, a buried chilled pipeline will act to maintain the permafrost along the line.

4.4) Restoration and Revegetation. This will be spoken to by D.L. Dabbs. Following pipelaying and backfilling of the ditch, the plant cover on the pipeline right-of-way will be restored as completely as practical. Following winter construction the right-of-way and backfill mound over the pipeline will be seeded and fertilized. Revised revegetation specifications and techniques of implementation are contained in Appendix C.

As a possible aid in revegetation in revegetation in tundra areas, approximately the upper 18 inches of the tundra will be stripped from the ditchline prior to ditch excavation and stored outside the spoil bank area. Following ditching and backfill operations, the organic material will be replaced on top of the backfill mound. Even if only a small amount of the tundra vegetation survives this harsh treatment, the the organic material will serve as a mulch for re-establishment of the tundra vegetation and provide added insulation to the backfill mound.

On slopes greater than 3% it may be necessary to provide extra treatment over and above seeding and fertilization to establish an erosion resistant plant cover. This treatment may take the form of hand planting of shrub cuttings separately or together with the laying of erosion control mat to prevent washout of seed and fertilizer and to provide an insulative cover. Abandoned roads and borrow pits will be recontoured and seeded. Borrow pits may require extra treatment in the form of salvaging organic overburden prior to operations in the pit followed by the replacement of the overburd en which will be mechanically worked into the soil, followed by seeding.

The applicant recognizes the variability of climatic conditions which may affect the success of re-seeding programs. A right-of-way surveillance and monitoring program will be established to detect and identify areas which require further treatment in the form of seeding, fertilization or hand treatment on the ground. Maintenance of the right-of-way will continue for the lifetime of the project, though it is anticipated that most areas will have a stable plant cover established within the first three to five years.

There will be a slide presentation here on re-vegetation.

4.5. Drainage and erosion control and slope stabilization measures. The techniques for both drainage and erosion control and slope

stability having been illustrated by the geotechnical panel called in Phase 1, and the hydrological design methodology has been fully outlined in a report entitled: "Drainage & Erosion Control - Proposed Measures and Description" (Northern Engineering Services Co. Ltd., March 1975)

The slope stabilization techniques have been outlined in "Slope Stability in Permafrost Terrain" (Northern Engineering Services Co. Ltd., December 1974). Hydrologic considerations will be dealt with later in the testimony.

This is sub-heading 5. Impact Assessment, this will be given by R.A. Hemstock. Under this Section 5 is 5.1, impact on resources.

The project will require use of 33 square miles for the life of the project and temporary use of an additional 8.5 square miles of land in the Territories. Land required for the right-of-way will not be preempted for exclusive pipeline use, as trapping, hunting, etc. can carry on over the right-of-way. Given the vast land area of the Territories we do not consider this impact to be significant.

With respect to borrow, the DIAND granular materials inventory has estimated reserves in the Mackenzie Valley to be in excess of 900 million cubic yards. The total requirement of the Arctic Gas project for DIAND Class 1, 2 and 3 materials is estimated to be about 30 million cubic yards. This

represents approximately 3.4% of the total reserves. Accordingly, ample reserves would remain to meet foreseeable requirements, although we recognize that because of uneven distribution of resources some long hauls may be involved.

5.2. Impact of construction,

The removal of vegetation and damage to the organic mat are the major causes of change to the existing thermal regime in permafrost terrain. Removal of the vegetation, for example, could result in a decrease in surface insulation and alterations in surface reflectivity, thermal conductivity and diffusivity of the organic mat, rates of evapo-transpiration and other micro-climatic factors. Where these conditions do occur and they are not offset by cover restoration and re-vegetation, changes in permafrost terrain can result in an increase in the thickness ofthe active layer and ponding and channelization of surface runoff. We recognize that in those situations where the depth of the active layer is increased, a potential for thermokarst development does exist and that direct measures for the control of drainage may be required. Disturbance to the organic mat will be minimized in Arctic construction areas, cut grading will be kept to the minimum, and construction will utilize snow roads and working surfaces.

On slopes and sensitive terrain (for example, at a few river crossing locations) clearing of the pipeline right-of-way may be left until immediately prior to pipe-laying operations to minimize

degradation following disturbance. In such situations the implemen tation of erosion control and slope stabilization measures will be carried out immediately following pipeline construction. As pipe-laying and construction of erosion control measures will occur prior to snow melt in the same winter as construction, there will be little requirement for temporary erosion control measures. Similarly, gravel fill may be placed immediately following pipe-laying operations on slopes that are potentially unstable on thawing. The gravel fill significantly increases terrain stability if degradation occurs following removal of the forest cover.

The maintenance and/or augmentation of snow cover on the right-of-way will be a feature of Arctic construction provides a protective cover over the ground vegetation and provides a base for construction of snow roads for the movement of men and construction equipment. The snow road tests demonstrate that the impact of construction on vegetation along the right-of-way, protected by a snow road, will be minimal and recovery of the vegetation will be rapid.

Terrain modifications caused by the development of borrow pits and quarry sites, construction pads, and access roads are themselves changes to the natural topography that will persist. However, the total area involved is relatively small and for the most part will be restored for wildlife. Where appropriate, these areas will be recontoured and re-vegetated prior to abandonment.

In summary, it is our opinion that the impact of construction activities on terrain will not be significant or of a long-term nature.

5.3 Impact of operations and maintenance. The operations and maintenance activities have been described in detail in Phase 1. As the anticipated risk of a major failure is very low, so too is the likelihood of major terrain disturbance resulting from unscheduled repair operations. Flexibility in scheduling permanent repairs will lessen the risk of significant terrain damage. If damage does occur, restoration and re-vegetation will be carried out. Routine operations and maintenance will primarily employ aircraft. Overall we are of the opinion that the impact of operations and maintenance on terrain will be minimal.

Section 5.4. This section will be presented by J.I. Clark, called impact of a chilled pipeline. The plan calls for the pipeline to be operated in a chilled mode throughout most of its length north of the 60th Parallel. The last point where chiling facilities are located is at compressor station ME-15 at Milepost 674. The last point of cold flow (that is where gas temperatures are continuously below 0 degrees Centigrade) once full pipeline operation is achieved, is at compressor station ME-18 at Milepost 810 north of the Alberta-Northwest Territories border.

Although many of the potential engineering and environmental problems that may occur as a result of permafrost degradation following clearing

of the right-of-way and surface disturbance are minimized by its use, chilled pipeline operation may create a new set of problems that must be considered. For instance, the operation of a pipeline at temperatures less than 0 degrees Centigrade (32 degrees Fahrenheit) in unfrozen ground will result in the development of a frozen zone or frost bulb around the pipe. The size and configuration of the frost bulb will depend on the operating temperature of the pipe, burial depth, local climatic conditions, temperature and rates of groundwater movement, and time since initiation of pipeline operation. Under adverse conditions, it can be anticipated that the development of the frost bulb around the buried pipe may interrupt subsurface drainage and result in a potential for frost heave. These effects are discussed in the following sections.

In permafrost terrain the operation of a buried pipeline at temperatures less than 0 degrees Centigrade (32 degrees Fahrenheit) may alter the thickness of the active layer over the pipeline, but otherwise has little effect on terrain. The results of CAGSL studies have shown that rates of water migration in permafrost soils are sufficiently small to effectively preclude significant frost heave in frozen ground over the operational life of the pipeline.

THE COMMISSIONER: Well, I guess that's settled then.

THE COMMISSIONER: Well, I guess that is settled then, Mr. Carter, is it? We can move on to other matters?

MR. CARTER: That is right.

THE COMMISSIONER: Go ahead, Miss Minning, we are just --

A Oh, I know.

5.4.1. This section will be presented by R.L. Harlan. Effects on Surface and Subsurface Drainage. The results of the geothermal analyses have shown that in permafrost terrain the operation of a buried chilled pipeline may affect the depth of the active layer over a distance of 10 to 20 feet on either side of the pipe. Whereas the ground over the pipe will freeze in winter as will the rest of the active layer, the presence of the cold pipe will not prevent the development of an active layer in summer. This has been confirmed at the test facilities both in Canada and Alaska.

The geothermal analyses have further shown that the base of the active layer over the pipe will be somewhat higher depending upon the depth of burial and climatic zone, than that over the remainder of the right-of-way. If adequate drainage measures are not provided, this could result in ponding of water on the upslope side of the pipeline right-of-way. The effects, however, would be localized due to the natural variations in the ground surface and in the depth of the active layer. Water ponded on the upslope side of the right of way will tend to move

laterally and cross the pipeline where the elevation of the ground surface or base of the active layer over the pipeline was lower. In general, the tendency for ponding to occur on the upslope side of the pipeline will be confined to natural depressions. FOr all but the gentlest slopes, e.g. less than 2 %, the effects of ponding will be limited to the right-of-way.

To provide for the redistribution of water across the backfill mound over the pipeline, a variety of techniques have been proposed. These are described in the Application. Mound breaks, for example, wil l be provided at natural drainages and at intervals along the right-of-way. The spacing of mound breaks will be sufficient to prevent the accumulation of surface and subsurface runoff intercepted by the pipeline during a design storm event from obtaining "erosive" velocities. As dictated by environmental as well as economic considerations, additional erosion protectionwill be provided as required. This protection will be provided through the use of select backfill, granular protection, riprapping and physical control measures such as diversion dikes, ditch plugs and disperson barriers. While the physical control measures are intended for stabilization and protection of the pipeline right of-way during the post-construction period until a protective vegetative cover can be re-established, revegetation will provide the primary means for erosion control in the long-term. In the more northerly portions of the route, it is anticipated that up to four

or five years may be required before revegetation can be depended upon for protection of the right-of-way and the backfill mound. In permafrost terrain, Arctic construction techniques will be employed which will minimize surface disturbance and erosion on the right-of-way. In the more southerly portions of the route, however, the time required for re-establishment of the vegetative cover is much shorter. Under favourable conditions, the time required for re-establishment of an effective vegetation cover may be as short as one g rowing season.

We recognize that there willbe situations, such as on steep slopes at river crossing locations, where physical erosion control measures will be required to protect the integrity of the pipeline and to minimize erosion.

Based upon analyses of hydrologic and climatological conditions along the pipeline route, design criteria and generalized designs are being developed for drainage and erosion control . THese will serve as guidelines for implementation of the proposed design in the field. Final selection and placement of alternative control measures must and will be made in the field prior to and during construction. A program of regular surveillance and maintenance is planned to correct any problems should they develop,to maintain effectiveness of the control measures and to provide for refinement of design criteria based on the performance of the various control measures.

With regard to the effects of interruption of subsurface drainage on downslope soil-water conditions, it is reemphasized that the operation of a chilled pipeline will not prevent the development of an active layer over the pipe or prevent all movement of water through the earth mound over the pipe. ALthough the interruption and diversion of part of the subsurface flow is inevitable at least during short periods of the yar, the effects will be largely local in extent. Normal dispersion of subsurface flow down slope of the pipeline will act to minimize the effect of local interruptions of flow and changes in soil-water conditions. Rain fall and snowmelt will also serve to restroe soil - moisture conditions downslope of the Pipeline. For these reasons there will not be a significant-differenc3 in soil moisture conditions up slope and downslope of the pipeline which could lead to a gradual shift in plant species composition.

To place the magnitude of the potential problems due to interruption of subsurface drainage in perspective, within the dis-continuous permafrost zone between Travaillant Lake at Milepost 221.0 and the Alberta/Northwest Territories -- a distance of approximately 582 miles -- only about 7% of the proposed alignment is on cross slopes greater than three degrees. In total this represents about 41 miles. Of these 41 miles, less than 9 miles are on slopes greater than 10 degrees. Of importance is the fact of all cr oss slopes greater

than 10°, less than one miles is classified as being in unfrozen terrain of high to moderate permeability.

The Applicant recognizes that during freeze-up in the fall of the year interruption of flow in the active layer could result in an increase in incidence of ground icings along the pipeline right-of-way. As conditions favourable for icing formation will exist only for a relatively short period in the fall or early winter, the possible increased incidence of icings is not considered to constitute an important factor from an environmental point-of-view or to adversely affect the integrity of the pipeline. The Applicant recognizes that the occurrence of ground icings may affect the performance of the drainage and erosion control measures. Where the performance of erosion and drainage control measures is affected by the occurrence of a ground icing, appropriate corrective measures will be taken as part of the regular maintenance work. In those situations where icings present a recurring maintenance problem, steps can be taken to force the occurance of the icing upslope and away from the pipeline right-of-way. There will be a slide presentation on ground icings right here.

Section 5.4.2 Frost Heave.

J.I. Clark. As noted previously, although the chilled pipeline concept eliminates many of the potential problems due to terrain disturbance and degradation of the permafrost, it introduces other problems. One of these is related to frost heave and

its effect on the terrain and the integrity of the pipeline. The effects of frost heaving on the pipeline and on the terrain have been considered in the extensive studies conducted by Arctic Gas. In considering the effect on terrain, it is convenient to group potential frost heave problems into two categories:

Category 1: Frost heave in permafrost soils;

Category 2: Frost heave in unfrozen ground.

The first section, Frost Heave in Permafrost Soils. The applicant recognizes that theoretically moisture migration and frost heaving is possible in permafrost or frozen soils and has examined this problem in considerable detail. Geothermal analyses have shown that in permafrost terrain the operation of a buried, chilled pipeline will not significantly alter the natural thermal gradients at depth beneath the pipeline; consequently, moisture migration due to the presence of thermal gradients directly beneath the pipeline will not be significantly affected. It is recognized, however, that the thermal gradients and hence moistufe transfer in the immediate proximity to the pipe will be affected. The implications with regard to frost heaving can be shown to be minimal. In the applicant' judgment, therefore, frost heave in permafrost does not constitute a potential problem from either an environmental or engineering point of view.

This is case two: Frost Heave in Unfrozen Ground. In the continuous permafrost

zone the only unfrozen ground of significant areal extent along the proposed route, in which the pipe would be buried, is located at riv er crossings. Although the Applicant has not conducted test drilling at all river crossings, it is recognized that there is unfrozen ground below some rivers but that for other rivers, which have small summer flows and which freeze off in the winter, most of the ground below them is frozen. The Applicant has examined in the field all river crossings and has observed that the beds of the majority of rivers consist of non-frost susceptible gravel. Detailed test drilling to be carried out prior to final design, however, may indicate that there is unfrozen frost susceptible ground beneath the gravel bed in some of these rivers. Moreover, some of the smaller rivers and the Mackenzie Riv er itself have fine graned soils beneath the river bed, which are not frozen. In the case of the smaller river crossings which have fine grained soils in the riverbed it is proposed that the crossings will be buried at sufficient depth so that the overburden pressure will restrict the rate of heave to within tolerable limits.

Thus the depth of burial required to cross frost-susceptible soil bed will be determined on the basis of a thermal analysis taking into account both frost heave and the freezing off of the soil above the pipe, rather than on the basis of scour considerations.

In the case of the Mackenzie, the depth of burial required for scour considerations is likely greater than the depth of overburden required to inhibit frost heave, and it will therefore govern. The load on the frost front at the burial depth will be substantial so that the potential rate of heave will be significantly lower than if the same soil were near the ground surface. The results of our study and others on frost heaving clearly shows the dramatic effect of an increased overburden pressure on reduction and rate of heave. For frost-heaving around a pipeline at major river crossings mainly to be taken into account during design, and method of analysis employed will be similar to those used where the pipe is buried in unfrozen ground in discontinuous permafrost zone.

These methods have been developed by Arctic Gas during its major study of frost effects initiated about 1 1/2 years ago. The applicant believes that its present method of predicting frost heave is conservative so that the field, laboratory and engineering studies are planned to continue to 1975. This will permit further refinement of the method of analysis to increase the base

of field analysis and frost heave data for soils along the route.

5.5 Effect on warm pipeline operation.

5.5.1 Thaw settlement. The operation of a buried pipeline at temperatures above zero degrees Centigrade (32 degrees Fahrenheit) in permafrost terrain will, in the long run, result in degradation of the permafrost. The rate at which permafrost degradation will occur depends on a number of factors including the temperature of the pipe and the ground, and the ice content and its distribution in the permafrost.

The applicant currently plans to design the systen to conduct gas at above freezing temperatures south of Station M-18. This means that approximately 170 miles of pipeline will pass through discontinuous permafrost with the gas at above zero degrees Centigrade. This area of the discontinuous permafrost zone is believed to be of low ice content with permafrost occurring in small scattered areas. The applicant recognizes that there is likely a zone within which the last point of cold flow can be optimized so as to present the most favorable combination of limited potential forthaw settlement and limited potential for frost heave. Studies to further define this zone are currently under way.

The applicant appreciates the fact that differential settlement of the pipe and ground surface may result along this section of the

pipeline and excess pore water pressures and reduced soil shear strengths can be generated during thawing of frozen soils. It is further recognized that under extreme conditions liquification or zero effective stress conditions may be induced resulting in slope instability and loss of bearing capacity. Techniques are available to take these features into account during final design of the pipeline.

5.5.2. Erosion due to thawing of ice-rich soils. The general principles for erosion control are:

1. To construct from select backfill, breaks in the pipeline mound at all identifiable natural drainage channels;
2. To provide additional breaks where necessary to direct surface flow across the mound before erosive flow velocities are achieved during a design storm event;
3. To protect the mound in areas of high erodability with select backfill; and
4. To provide special measures such as diversion dikes and riprap as required.

In general, the same design criteria will be applied to both ice-rich and thaw stable soils except that the pemissible velocity criteria will be reduced for ice-rich soils. As a result, exposed ice-rich soil will generally be provided with protection by select backfill except in areas of negligible slope. Arctic Gas accepts the fact that regular maintenance willbe required to maintain the effectiveness of the drainage and erosion control measures.

This is 5.6, Impact of abandonment. This will be R.H. Harlan.

5.6.1, previously unfrozen ground. Where the pipeline is operated at below freezing temperatures in naturally unfrozen ground, a frost bulb will be formed around the pipe. The size of the frost bulb will vary along the route and will depend upon many factors, such as average local air temperatures, thermal properties of the soil, operating temperatures of the pipe and the number of years that the pipeline is operational before abandonment.

By definition, the frost bulb around the pipe at the time of abandonment will be permafrost. Although there are difficulties in predicting whether this artificially maintained permafrost will degrade or not, it is the applicant's judgment at this time that most, if not all, of these types of created permafrost situations will eventually thaw out after the pipeline is abandoned. The frost bulb will thaw back slowly after the pipeline becomes inoperative. This process will normally take more years than it took to form the frost bulb. This is because the average temperature of the ground around the operating pipe is more degrees below freezing than the natural unfrozen average ground temperatures are above freezing. Because of the low rates of thaw associated with this type of frozen ground regression, the rates at which water is released is also low. This means that in most cases very low excess pore pressures will develop and so the potential for slope failure will also be low.

During the development of the frost bulb the local ground surface above the operating pipe will slowly rise to a greater or lesser extent depending mostly on the soil and water table conditions, due to the expansion of the in-situ water upon freezing and to possible ice lens formation. As the frost bulb thaws out after abandonm ent, the level of the ground surface will slowly become lower, perhaps an average of an inch or two per year, and tend towards its original level.

5.6.2. Permafrost terrain.

In some cases mainly in the southern part of the discontinuous permafrost zone, the removal of the trees and shrubs from the right-of-way during construction could cause the permafrost to degrade in the long term. The operation of the pipeline at below freezing temperatures will counter the tendency of the permafrost to thaw out. The fact that permafrost will exist naturally along side of the right-of-way will also tends to maintain the permafrost in the right-of-way, during the years that the pipeline is in operation . Also some of the natural shrubs and trees will be allowed to /re-establish themselves so that when the pipeline is finally abandoned the local permafrost situation will likely be stable.

It is possible in some cases after the pipeline is abandoned, that the permafrost along the right-of-way would thaw out in the long-term. This could be due to factors such as changes in the vegetation or long-term changes in climate.

Although at this time it is very difficult to predict with confidence whether or not permafrost will thaw out in the long-term, it is possible to reasonably predict the rate of thaw if in fact the permafrost would degrade with time. This information, along with knowledge of the ice content of the permafrost, can then be used in the determination of surface settlement and in the evaluation of slope stability. An indication of the areas along the right-of-way where permafrost degradation may occur could be obtained by observing the changes in the permafrost table near the edges of the right-of-way after several years of operation.

This is the next section on water resources. First section of this section is the general comment by -- to be led by Peter McCart.

The proposed pipeline route along the Northwest Territories lies largely within the drainage basin of the Mackenzie River System. Although the Yukon Coastal plain, along the Yukon coastal plain the proposed route crosses numerous drainages which flow out of the British Mountains northward to the Beaufort Sea. The Mackenzie River system drains an area of approximately 700,000 square miles. The two largest tributaries to the Mackenzie in terms of drainage are the Liard and Great Bear Rivers, draining 107,000 and 60,000 square miles respectively. The Liard River doubles the flow of the Mackenzie at its confluence near Fort Simpson, and markedly affects spring breakup and flooding on the Mackenzie. The Great Bear River, on the other hand,

has a more stable flow than the Liard, and exhibits little influence on the Mackenzie River floods. The Peel River, which has its origin in the Ogilvie Mountains of the Yukon, join the Mackenzie downstream at Point Separation. Although the drainage area of the Peel is only 29,000 square miles, the maximum recorded peak flow is in excess of 200,000 cubic feet per second. The average discharge of the Mackenzie River to the Arctic Ocean is on the order of one million cubic feet per second.

From Wrigley northward to about San Sault Rapids, most of the smaller streams enter the Mackenzie along the east bank and have their origin in the Franklin Mountains. These streams typically have fairly steep gradients and are fast-flowing in their upper reaches, but tend to be more gentle in their lower reaches. Although flow in these streams is normally small, they may experience heavy spring runoff in several flood peaks of short duration following heavy mid-summer rains in the upland areas. The larger tributaries in this section of the basin have large drainage basins which extend well eastward of the Franklin Range. Here the topography, although hilly, is more moderate than in the Franklin Mountains. The landscape is dotted with numerous lakes ranging in size from a few acres to major water bodies such as Great Bear, Blackwater, and Fish Lakes. These lakes have a moderating effect on stream flow due to their regulating capacity. As a result, most of the larger rivers exhibit rather stable flow characteristics.

North of San Sault Rapids the terrain is generally flatter. Numerous shallow lakes in this area have a moderating influence on stream flow. Stream channels are frequently frozen to the bottom in winter, and flow is small. Flooding is common in the spring due to the widespread occurrence of permafrost and the limited opportunity for infiltration. From west of Fort McPherson to the Travaillant Lake area and northward to Richards Island the pipeline crosses three major rivers: The Peel, the Mackenzie upstream of Point

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Separation, and the Mackenzie at Swimming Point. No other significant river crossings occur in this part of the route, much of which is characterized by flat or gently rolling, poorly drained terrain.

The streams and rivers of the Yukon coast flow northward and westward across the alluvial plains to the Beaufort Sea. They are swift and turbulent for short periods during summer, but are often frozen to the bottom in winter. Typically the coastal rivers display wide, shallow, braided channels, subject to rapid and intensive lateral shifting. Channels are not well defined or persistent and the valleys are in some places subject to extensive icing conditions in winter.

Information on streamflow in the vicinity of the proposed pipeline route is limited largely to a few stations on the Mackenzie River and its larger tributaries. Stage discharge relationships for the streams and rivers of the Mackenzie Valley and Yukon Coast are not generally available, particularly for the smaller drainage basins. To provide information on the precipitation and streamflow, regimes on several of these smaller drainage basins, a field data collection program has been initiated. The purpose of this program is in part to provide baseline data on the characteristics of summer precipitation in selected areas on the proposed pipeline route which are remote from the existing meteorological network maintained by Environment Canada. Field data are also being obtained for the calibration and verification

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f the hydrologic models proposed for optimization of drainage and erosion control measures and river crossing design.

On the proposed pipeline route areas of significant groundwater activity have identified. Both of these areas are of particular portance from a fisheries point of view in that the jor springs typically feed over-wintering areas. One these areas is on the Yukon coastal plain and extends from the Alaska-Yukon border along the coastal in to approximately Milepost 290. Groundwater scharge from springs in this area may be characterized fresh to moderately fresh with observed conductivities the range of 200 to 425 micromhos/cm. Water temperatures at the spring source are typically in the of zero to four degrees Centigrade.

THE COMMISSIONER: Miss Minning, I take it that what you mean is that the fish over-wintering beneath the ice receive a continuing supply of water from the springs, is that what is happening?

A I think that's why it's nfrozen there, yes. I don't want to say the wrong hing, I'm not a fish person.

Q Oh, I see. Who is discuss- this?

A This is Peter McCart.

Q Oh.

A He would be very angry if I said the wrong thing.

Q Well, we know how to handle

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In Chief

like that.

A The second major area ...ndwater activity lies along the Franklin Mountains ...n the Donnelly River at Milepost 317 and the ...wlake River at about Milepost 606. This area is ...acterized by numerous springs and seepages. Dis...e from the springs is variable and the water qual...aries from fresh to highly mineralized. Conducti... in excess of 3000 micromhos per second have ...measured. Water temperature in major springs are ...variable, ranging from close to zero degrees ...igrade to 18 degrees Centigrade, measured at a ...g in the vicinity of the Ochre River. Evidence ...ates that this area is one of regional groundwater ...ge. The main source or recharge area is probably ... Mackenzie Mountains. Areas of local groundwater ...harge are also prevalent.

Areas of less significant ...dwater activity have also been noted on the ...ior route to the west of the Northwest Territories-... border. These areas, however, are of limited ...ance from a fisheries point of view.

Because of the implications ...hilled pipeline operation on interruption of ...dwater flow, Arctic Gas and Northern Engineering ...ces Co. Ltd. have initiated a field program to ... the origin and to define the nature of important ...ngs on the pipeline route. The object -- the ...ective of this program is to obtain sufficient ...rmation to be able to assess quantitatively the

impact of pipeline operation. The program will combine drilling and geophysical exploration. Whereas the source of many of the springs and groundwater seepage zones along the Franklin Mountains is known from past investigations, or can be inferred from hydrogeochemistry, this is not true for many of the major springs on the Yukon Coastal Plain.

Climatic conditions along the proposed pipeline route vary from coastal Arctic near the Beaufort Sea to interior sub-Arctic along the Mackenzie Valley. Records of temperature and precipitation have been continuously maintained at Fort Good Hope and Fort McPherson since before the turn of the century and in the Fort Norman-Norman Wells area for about 70 years. Most other stations in the Mackenzie were established after 1940.

In recent years the meteorological network in the western part of the District of Mackenzie and coastal areas of the Beaufort Sea has been expanded to include the Dew Line stations at Shingle Point and Komakuk Beach.

The impact of the Arctic Gas project as it relates specifically to water resources is mainly on fisheries. In this regard, Arctic Gas recognizes that there are areas of concern that relate to protection of spawning grounds and over-wintering areas. The impact as it affects the water supply for settlements along the pipeline route will be negligible. The impact of chilled pipeline operation on the disruption of surface runoff and drainage in the active layer

has been discussed previously and will not be considered further here.

Next section, which is Section 2. Water use requirements. This will be G.L. Williams discussing this.

The main water-use requirement will be during the construction phase. This will include domestic requirements for construction camps, for snow-making and snow road construction, for ditch flooding, and pipeline testing. Water requirements for operation and maintenance of the pipeline will be--will in general be minimal.

The water requirements for pipeline construction will be obtained from surface sources including both lakes and streams and locally from groundwater sources. The details of how the water supply requirements will be met for the different construction spreads are part of final design. The water supply requirements and potential water sources for two typical spreads has been detailed in the response to question No. 52 in the Pipeline Application Assessment Group's requests for supplementary information.

A number of governmental regulations and guidelines are applicable to water supply development and waste disposal in the Territories as well as the provinces. These have been considered in the development of standards for the Arctic Gas project. The applicant is confident that these standards as set out below will meet or exceed those

[illegible] by existing legislation and by sound engineering and environmental practices.

Although water for camp use will come from a variety of sources, water quality after treatment will meet existing public water supply standards (viz, it shall be clear, sparkling and devoid of taste, odor or harmful bacteria and be within specified chemical quality criteria).

THE COMMISSIONER: This is Mr. Williams speaking.

A Waste water treatment standards will be: a. Temporary Camps (200 man day duration): Primary treatment and disposal to pits. b. SIte preparation and material receiving camps (100 man camps with possible year round operation): Secondary treatment of all water borne wastes and incineration of other organic wastes. c. Construction camps: Depending upon the activity season and number of man-days of use, waste water disposal from pipeline camps will receive some form of "Secondary" treatment prior to disposal. "Primary" treatment will be sufficient in the case of smaller camps.

Number three: Water Quantity: a. For small camps (i.e. 20 men), the water requirements are estimated at 100 IMP gal/cap/day. b. For camps of 100 persons or more, facilities will be designed for 80 IMP gal/cap/day. A 200 man module, for example, would have facilities to provide 16,000 gallons per day (or 11 gallons per minute average). c. Each camp would be provided with storage facilities capable of providing an adequate supply for emergency use. d. Unless exceptional circumstances exist water will not

be recirculated or recycled. e. for all practical purposes, disposal facilities will be designed to dispose of an equal quantity of water to that provided as noted in (a) and (b) above. f. All facilities will be designed to cope with the peak flows inherent with shift changes.

2.1. Water Sources and Treatment. THe Mackenzie River currently serves as the main source of water for most communities along its banks. ALthough water from the Mackenzie will undoubtedly be used, a number of other water sources will be developed. For example, airphotos and topographical maps of the pipeline route indicate a significant number of rivers, streams and lakes that are potential water sources. Each potential source will be evaluated in perspective with projected water requirements as to its dependability, quality , and environmental significance prior to development. The larger rivers, streams, and lakes can provide high quality water requiring only chlorination. Many of these will provide a year round supply.

In southern areas, however, many of the lakes produce water high in organic matter and iron, which may affect taste. [illegible] water treatment units capable of removing the iron and organic matter and producing water of acceptable quality will be used. The [illegible] and processes will be employed for camps operated during summer months when many northern [illegible]. Similarly where special problems such as high salinity

:iron contents are encounted, appropriate treatment will be
ovided.

.er will be chlorinated and clarified, if necessary, prior to ng put into the camp storage tanks. Distribution from storage ks will be by pressure-pipe systems. Cartridge type filters .h disposable cartridges will be installed on all distribution .es to act as a final treatment. Periodic testing will be done .h bacterial samples submitted as required.

Waste Water Treatment and Disposal

a) For small mobile camps:

I) Kitchen, laundry and shower water will be discharged to the ground surface away from areas of foot traffic

II) Toilets will be minimum water use types with storage compartments. These will be emptied into pits prepared for that purpose. The location of the pits will be marked.

b) For camps occupied on a year round basis, the basic waste water treatment component will be open lagoons with a one year retention capacity. Such units are in successful operation in many northern communities, they are economical, and require little maintenance, while producing a quality effluent.

Where lagoons are not practicable "package" mechanical treatment units capable of providing secondary treatment will be installed.

(c) For camps occupied

only the winter construction season, a package mechanical treatment unit with secondary treatment capability will be provided.

Winter construction camps are designated to be located on gravel pads. The mechanical unit will be backed up by a lagoon constructed on the edge of the gravelled area. The lagoons will be capable of containing at least 10 days of total flow with ample allowance made for ice formation. Discharge from the "backup" lagoons will, where practicable, be into swampland or heavy bush. DIscharge directly into bodies of water will be avoided. Chlorination of effluents will also be avoided except where there is a possibility of contamination of a domestic water supply.

Sewage sludges resulting from the the secondary treatment processes will be incinerated with the as disposed of as solid wastes.

The recommended treatment process for waste water and the one preferred by Arctic Gas is called the "physical-chemical" process. This involves precipitation of solids by chemicals with subsequent disposal of the sludge by incineration. Secondary treatment standards are met by filtration. The major advantage of this method over "biological" methods is the speed with which a plant can be put into operation and also the degree of control of the process by the operator.

2.3 Solid Waste Disposal. All organic wastes will be incinerated. Larger camps will

use high temperature dual chamber incinerators to maintain clean air standards. Ash and non-combustables will be burned.

Landfill processes approved by the Territorial COvernment will be used. Non-combustible waste will also be collected and buried except for major equipment items which will be collected in central depots for subsequent recovery and recycling.

2.4 Water Supply for Compressor Stations and Maintenance Camps. As maintenance camps at the compressor statoins are occupied on a discontinuous basis large storage tanks capable of providing the water supply requirements for 6 to 8 month periods would be installed. The methods of filling will vary from camp to camp but generally would occur once or twice a year. With regard to waste water disposal, each compressor station will have from pipeline construction a single or dual cell lagoon capable of retaining 8000 man-days of wastes. It is the intent that these will be utilized to receive raw sewage. With the reduced intermittent occupation such lagoons will have in the order of 1 years' retention capacity. The effluent from such a lagoon will meet secondary treatment standards.

Likewise, the incinerators redundant from from the pipeline construction phase will be retained inservice on the compressor stations for disposal of combustible wastes.

2.5. Hydrostatic Testing. Two alternative methods of hydrostatic testing during

the winter are available, warm-water testing and water-methanol testing.

Warm water testing involves the heating of water to about 50°F (10 degrees C) and pumping it through the test section until the temperature of the water being discharged reaches a specified temperature, usually about 35° - 40°F (3-5 degrees C). Test sections probably would not exceed five miles in length, and the amount of water used per test section would be about three times the volume of the test section. When water is being drawn from a supply point, it is required at a rate of about 4000 USGPM.

With warm-water testing, there is always the risk of freezing the test medium. In addition, large water sources are required at frequent intervals along the route, and water usage is high. Warmwater testing is not a desirable test method in permafrost regions and therefore it is not likely to be used north of the 60th parallel.

Water-methanol testing involves the mixing of water and methanol to form a solution whose freezing point is less than the minimum expected backfill temperature at pipeline depth. The strength of the solution will vary with region, but nrmally will not exceed 26% by volume. In the coldest region, the north slope of the Yukon, a solution strength as high as 29% methanol by volume may be required in the worst case.

Test sections will be about three miles in length. The same solution will be moved from one test section to the next, testing all the pipe in a construction section. The solution would then either be stored in the pipe until the next construction season, and re-used, or the methanol would be separated by a distillation process and mixed with water to make a new solution at the start of next year's testing program. Water requirements for water-methanol testing would be about 1/70th of those for warmwater test program.

At the end of the second construction season, the test medium will be disposed of either by dilution to a methanol concentration of about 1% followed by direct disposal onto ice over a large watercourse such as the Mackenzie, or by distillation to remove most of the methanol. After distillation, a residue containing less than 1% methanol will require disposal.

Disposal of solutions containing about 1% methanol onto ice over a watercourse such as the Mackenzie is considered because the methanol concentration is extremely low and the oxygen required to oxidize the methanol would be a very small percentage of the available oxygen. By disposing of the solution onto ice, evaporation and sublimation would reduce the methanol content in time. In addition, the release of the solution would occur gradually as the ice melts, at a time when the river flow is high.

Wherever possible, all water

which will be used for testing will be free of silt or harmful components, and will be filtered prior to use. The pipe will be clean and internally coated so no harmful components will be added during testing.

The use of corrosion inhibitors is not currently proposed but may be required for water methanol testing, especially if storage of the test medium in the pipe from one season to the next is used.

No. 3, this section will be presented by R.L. Harlan. Hydrologic considerations in route location and refinement.

With regard to route location and design of river crossings, two particular features of northern rivers should be noted. Because the Mackenzie River flows northward, freezeup occurs first in the lower reaches and breakup occurs first in the upper parts of the watershed. This gives rise to ice dams and ice jams forming with a temporary upstream increase in water levels and/or scouring. The effects of this temporary damming on scour and on pipe security have been evaluated. The second important feature of rivers and streams flowing through permafrost terrain is the unusually large reduction in flow during winter, which in some case may be naturally reduced to zero, particularly in the more northerly regions. Winter construction has both economic and environmental advantages under these circumstances.

In addition to the general considerations discussed above, a number of other factors have been considered in route location,

particularly at river crossings. For instance, preference has been given to location of river crossings in straight channel reaches rather than at a river bend where lateral migration of the channel could be accelerated by pipeline construction. Those factors affecting bank erosion, namely the resistance of the bank to erosion, velocity and depth of the adjacent river flow, and the angle of attack between the banks and the approach flow, were taken into account in route location. The factors were considered in detail by the panel -- by the geotechnical panel in Phase 1 and will not be considered further by this panel.

In the route location and refinement process, an effort has been made to avoid wherever feasible, difficult river crossing situations. To illustrate this point, the difference in hydrologic characteristics of the rivers on the west side of the Mackenzie River as compared to those on the east side was a beneficial factor in the decision to locate the pipeline route on the east side. Because of the greater extent and elevation of the Mackenzie Mountains compared to the Franklins, runoff on the west bank tributaries tends to be higher than for the east bank tributaries. The m ean annual 50-year floods for the Wrigley and Carcajou Rivers, for example, are 77,000 cubic feet per second and 97,000 cubic feet per second, respectively. The mean annual 50-year flood for the east side rivers varies from about 3,000 cubic feet per second to 34,000 cubic feet per second. The channels of the east bank tributaries are smaller and more stable

than their counterparts on the west side. The west side rivers are commonly braided with wide active flood plains whereas the tributaries on the east side commonly have a single channel.

Section 4. The Impact assessment. Section 4.1, Water withdrawal and waste water disposal. This will be presented by P.J. McCart.

The removal of water from lakes and streams along the pipeline route for domestic use, ditch-flooding, snow-making, and pipeline testing will have a negligible impact on the environment. Firstly, the total quantities of water required are small compared to the total water resources available. Secondly, prior to withdrawal of water from any source, the environmental effects of the proposed rates, timing and duration of water withdrawal will be fully assessed. Arctic Gas is aware that in several areas on the proposed route it will be necessary to avoid withdrawing water from sensitive areas or if a water source is developed in these areas, a minimum flood level must be maintained to protect downstream fish populations.

The discharge of liquid wastes from construction camps and compressor stations to swamplands will also have negligible environmental impact. The effectiveness of swamplands in disposal of domestic wastes is demonstrated by the example of Hay River (publication, Hartland-Rowe, 1973, "Use of Swampland as a natural sink for receipt of sewage effluent", Environmen tal-Social Committee, Northern Pipelines, Report No. 73-15; second publication,

Hartland-Rowe, R. and P.B. Wright, 1974, "Swampland for sewave effluent, final report." Environmental-Social Committee, Northern Pipelines Report No. 74-4) If treated effluent is to be discharged in a stream or river, it will be done so only if dilution will be sufficient to make any effect negligible.

Section 4.2, Construction activities. This will be done by G.L. Williams.

In the short term pipeline construction activities at river crossings may result in increased sediment loads. Insofar as the Mackenzie River and other major rivers are concerned, natural sediment loads arising from bank and chanel erosion during spring breakup will greatly exceed those caused by construction of a pipeline crossing. Moreover, the sediment introduced to the lower reaches of the tributary rivers from backwater effects due to ice-jamming will also be greater than that caused by pipeline construction across these rivers. For the crossing of the Mackenzie River at Point Separation, for example, it is estimated that the increase in suspended sediment load at a distance of 1,000 feet downstream of the crossing during dredging will be in the order of 55 ppm. At a distance of 4,000 feet downstream from dredging operations the increase in suspended sediment load will decrease to about 25 ppm by volume. These increases in suspended sediment loads are regarded as negligible compared to natural sediment loads in the Mackenzie River. The average suspended sediment load in the Mackenzie River as measured from Arctic Red River was

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551.9 ppm in June 1973, decreasing to 142.2 ppm in September of the same year. That's in a publication by Davies, K.F., 1974, "Hydrometric data summary Mackenzie River Basin, 1973." Environmental-Social Oil Development Report No. 74-8.

Conventional techniques which have been used extensively in pipeline engineering in the past have been developed to avoid long-term changes in the river regime. If a river crossing is not properly designed, the crossing could redirect channel flow to parallel the pipeline, thereby creating a new channel. To minimize the chances of this happening, river crossings are made at approximately right angles to flow in the channel. Further to reduce the possibility that lateral erosion may be induced that could expose the pipe beyond the sag points the crossings are made where possible at straight stable reaches.

The only permanent access roads required by the pipeline will be those that lead from stockpile sites to compressor stations, from proposed highways to compressor stations and from compressor stations to adjacent airstrips and borrow pits required for maintenance. On the basis of present plans only five streams are to be crossed by permanent roads to be constructed by Arctic Gas. Of thse only two -- a tributary to Oscar Creek at milepost 357 and an unnamed creek at milepost 533, approximately five miles south of the Ochre River -- have significant, identifiable fish activity. No permanent roads will be built along the right-of-way for construction purposes. Wherever possible, the access roads have been routed so as to avoid stream crossings. Where such streams are crossed, culverts or bridges will be designed to ensure that fish passage and that maximum runoff events can be accommodated.

Arctic Gas does not expect borrow operations in connection with pipeline requirements to significantly alter either the regional runoff or river regimes. Gravel, for example, will not be removed from streambeds in which there is flowing water. Borrow operations, however, will be carried out on "active floodplain", that is the area of the flood plain that undergoes seasonal flooding.

Borrow operatoins on the

active flood plain will generally be conducted during the summer to early winter. Wherever space permits, a buffer zone will be left between the borrow operation and the stream channel. In all cases, a berm will be built to separate the borrow pit from any channel with flowing water thus effectively avoiding increased siltation in the stream at any time of the year THe berm will be constructed to ensure its stability during all times of the year. Breaching of the berm will be carried out following the completion of borrow operations to ensure that the pit will be cleansed during the spring flood when silt concentrations are naturally high.

SInce any relatively small increase in silt loads from the borrow pit operations would occur during the spring flood, when natural silt loads are highest, it is unlikely that either fish or benthic invertebrate populations would be affected. The borrow pit excavation will not be deeper than the level of the adjacent streambed, and the borrow pit floor will be regraded to ensure a positive downslope gradient to the streambed so that no ponding will occur. Therefore, there should be no long term effects of borrow operations on aquatic habitats and fish and benthos populations. Stream channels will eventaully form a braided pattern within the flood plain, a pattern common to many streams.

As the depth of borrow operations willbe limited to the level of the adjacent streambed, borrow operations ;should not affect

overwintering fish populations whcih may be dependent on the passage of subsurface waters. Furthermore, the berm should prevent any silt-laden water within the pit from entering the stream because any groundwater migrating through the borrow pit area will be filtered by the berm material before entering the adjacent watercourse.

4.3 Operation and Maintenance. The operation and maintenance activities as they relate to the propose Arctic Gas Pipeline have been described in Phase I. These activities ;including minor repairs and routine surveillance will primarily employ aircraft for the movement of personnel and light equipment. Wherever practical, maintenance operations will be scheduled to correspond to those times when conditions are the least sensitive to environmental damage. As in the case of the impact on terrain, the impact of operations and maintenance on water resources will in the judgment of the Applicant be minimal.

4.4. Impact of Pipeline Operation.

4.4.1. Surface Waters. This will be R.L . Harlan. Arctic Gas has stated its intent to provide for the control of drainage and erosion on the pipeline right-of-way and at river crossing locations. The proposed measures will prevent the introduction of unacceptable sediment loads into the surface water bodies. THere should, therefore, be little adverse environmental effect of pipeline operation on surface waters. The effect of chilled pipeline

operation on icing occurrence is considered in the following section.

4.4.2 Groundwater. The concerns expressed by both the Pipeline Application Assessment Group and the Department of the Environment task force with regard to effect of chilled pipeline operation center on two main issues. First of all, the interruption of subsurface flow and its diversion to the ground surface in winter could result in the formation of an icing with the consequent interruption of the downstream water supply. Arctic Gas recognizes that in some situations, maintenance of the downstream water supplies is critical to overwintering fish populations. Secondly, the initiation of an icing in an area not normally prone to icing could, under certain circumstances, cause lateral deflection of spring runoff resulting in accelerated channel migration and intensified erosion of the banks. The possibility of this occurring, however, is regarded as small. IT is noted that many of the Yukon Coastal Rivers are naturally subjected to severe icing conditions.

Within the continuous perma frost zone, substantial areas of unfrozen permeable materials are found only beneath those rivers and lakes that do not freeze completely in winter. Within these unfrozen areas, groundwater flow is controlled mainly by the configuration of the groundwater table. At the proposed river crossing locations, for example, subsurface flow in the sub-river channel materials is

generally parallel to the slope of the river bed. Except in those situations where aquifer thickness changes significantly or there is a decrease in permeability in the downstream direction, the vertical component of groundwater flow is generally small.

It is recognized that any reduction in the unfrozen cross-sectional area available for groundwater flow due to the growth of a frost bulb around a buried pipeline will restrict subsurface water movement. this is inevitable unless the permeability of the remaining unfrozen cross-sectional area is increased through the use of drains or by replacing the in situ materials with coarser material of greater permeability. The reduction of subsurface fl!o around the pipe will result in the diversion of groundwater flwo upstream of the pipeline crossing. FOr an unconfined flow situation, subsurface flow will be diverted to the channel thereby augmenting flow in the river. For an unconfined flow situation, it is unlikely that a significant build-up of artesian pressures could develop within the groundwater system, In general, the downstream effects will be limited due to the fact that the hydraulic gradient and permeability of the river alluvium downstream from the crossing will not be changed from its natural state.

For most large rivers, augmentation of flow in the channel will be small. This is due to the small size of the frost bulb compared to typical depths of the unfrozen alluvium at major

river crossing locations. As the augmentation of flow over the pipe is small in relation to flow in the river, the pip;eline could have a negligible effect on the formation of icings at the pipeline crossing or on fish populations overwintering down stream of the crossing.

In those rivers and streams which freeze to the riverbed it can be shown that the zone above the pipe will freeze off relatively quickly,, e.g., within one or two years following startup of the pipeline, unless high groundwater flow velocities are sustained throughout the winter. The depth of freezing below the pipe will depend upon a number of factors including the extent and nature of the unfrozen areas, the rate of subsurface water movement in the unfrozen zone and groundwater temperatures. In some situations in which the rivers freeze to the bottom, permafrost occurs at a relatively shallow depth due to the three dimensional effects. For instance, the presence of permafrost beneath and to the sides of a relatively shallow channel area provides in essence massive heat sink which reduces the depth and lateral extent of such unfrozen zones .

It is further recognized that where there is a significant reduction in subsurface flow, the occurrence of icings may be initiated.

A slide presentation on river icings will be made.

In those situations where it is

important to maintain the downstream water supply, for instance to overwintering fish populations, the Applicant will provide for the maintenance of flow by the provision of insulated subsurface drains across the pipeline right-of-way or other appropriate measures. THe necessity for and replacement of sub-surface drainage, for example, will be determined from the Applicant's geothermal analysis of each situation as part of final design.

Where the possibility of channal migration due to the initiation of an icing at a river crossing is anticipated, the river banks will be protected by riprap or bank armour as required. Where unforeseen conditions are encountered, channel and bank stabilization will be provided through the proposed operation and maintenance program. Riprap or bank armouring will be provided as required to minimize adverse environmental effects and to protect the integrity of the pipeline.

FIve, Impact of Abandonment. ARctic Gas is not aware of any potential adverse effects of pipeline abandonment on water resources.

Miss G. Minning
In Chief

During construction, vehicular emissions and dust along the route will unavoidably occur as a result of construction and aircraft activity. Small amounts of unburned hydrocarbons, oxides of nitrogen, carbon monoxide, carbon dioxide, sulphur dioxide, sulphur trioxide, water vapor and suspended particulates will be generated as a result of operation of vehicles, construction machinery, , and support facilities associated with construction activities. The emissions from such operations will have only a small effect on the general air quality. They are relatively small in magnitude, are distributed over a relatively wide area, and are transitory in nature. About 10% of the weight of all exhaust emissions will be water vapor. This may result in the formation of ice fog under very cold winter temperatures, with inversions, and where there is a light wind. Although the presence of ice fog may restrict visibility and hamper construction activities, it is not considered to be harmful to the environment. The construction phase will not have any long-term impact on air quality. In the operation phase the only compressor stations -- oh, in the operation phase, only compressor stations will be a source of potential long-term effects on the atmosphere. However, the fuel will be natural gas, which is a very clean-burning fuel, and the influence of the compressor stations on air quality will be minimal in terms of toxicity in the exhausts and the area over which there may be an effect. The quantities of turbine exhaust gases vary somewhat depending on the

ambient temperature and the load conditions of the pipeline. At full load conditions when the ambient temperature is 77 degrees F. the 30,000 horsepower stations with refrigeration will produce approximately 5,315 standard cubic feet per second of exhaust gas. Of this quantity. 3.9% will be water vapor, 2.1% carbon dioxide, 77.5% nitrogen, and 16.5% will be oxygen. At an ambient temperature of minus 40 degrees F. the total exhaust gases will increase to approximately 5,690 standard cubic feet per second and the percentage of each component will be slightly changed.

In addition to the primary exhaust components listed above, small quantities of nitrogen oxides, sulphur oxides, carbon monoxide, and unburned hydrocarbons will be produced. The oxides of nitrogen will be present in quantities ranging between 59 parts per million and 130 parts per million, depending on the type of turbine, and will consist primarily of nitric oxide with a small percentage of nitrogen dioxide. The nitric oxide rapidly oxidizes to nitrogen dioxide in the atmosphere. The average concentration from a given station will contain in the order of 105 parts per million nitrogen oxides.

The sulphur oxides will consist primarily of sulphur dioxide with a small percentage of sulphur trioxide. The quantities of sulphur oxides in the exhaust gases will depend directly upon the quantities of sulphur in the fuel gas. Section 12 of the application (Tariff) specifies that the gas shall contain not more than 20 grains of total sulphur

per 100 cubic feet. However, the producers have informed us that the gas in both the Mackenzie Delta and Prudhoe Bay contains only negligible amounts of sulphur. Assuming the maximum limit in the gas specification, the exhaust gas would have a sulphur dioxide content at approximatley 6 parts per million. With less than 2 grains sulphur per 100 standard cubic feet, the sulphur content of the exhaust gas will be less than 0.6 parts per million.

Carbon monoxide in the exhaust gases is a product of an incomplete combustion. The quantity will depend largely on the efficiency of the turbine and the load conditions. At full load, the turbines are most efficient and will produce quantities of carbon monoxide ranging between 10 and 50 parts per million. At reduced loads the quantities will increase.

Unburned hydrocarbons in the exhaust gases are also a product of an incomplete combustion. They will be present only in negligible amounts.

The Federal Ambient Air Quality Objectives established under the Clean Air Act R.S.C. 1970, which were published in "Canada Gazette" on July 12, 1974, state the following limits for sulphur dioxide and carbon monoxide in the ambient air:
The maximum acceptable concentrations of sulphur dioxide are (a) 60 micrograms per cubic meter (.02 parts per million) average annually;

(b) 300 micrograms per cubic meter (.11 parts per

million) average for a 24-hour period; and
(c) 900 micrograms per cubic meter (.34 parts per million) average for one hour.
The maximum desirable concentrations of sulphur dioxide are stated as exactly one-half of the maximum acceptable concentrations.
The maximum acceptable concentrations of carbon monoxide are: (a) 15 milligrams per cubic meter (13 parts per million) average for an 8-hour period; and
(b) 35 milligrams per cubic meter (30 parts per million) average for a 1-hour period.
The maximum desirable concentrations of carbon monoxide are: (a) 6 milligrams per cubic meter (5 parts per million) average for an 8-hour period; and
(b) 15 milligrams per cubic meter (13 parts per million) average for a 1-hour period.

The Federal Ambient Air Quality Objective No. 2, which were published in the "Canada Gazette" on February 12, 1975, state the following limits for nitrogen dioxide in the ambient air:
The maximum acceptable concentrations of nitrogen dioxide are: (a) 100 micrograms per cubic meter (.05 parts per million) average annually;
(b) 200 micrograms per cubic meter (.11 parts per million) average for a 24-hour period; and
(c) 400 micrograms per cubic meter (.21 parts per million) average for one hour.
The maximum desirable limits are 60 micrograms per cubic meter (.03 parts per million) average annually.

Miss G. Minning
In Chief

The applicant has hired as consultant Western Research & Development of Calgary to make calculations to predict the ground level concentrations of nitrogen dioxide and sulphur dioxide for a wide range of assumed atmospheric conditions including neutral atmospheric conditions, plume trapping conditions, intense inversion conditions, and calm conditions. In all cases, these calculated quantities are below the limits stated in the Federal Ambient Air Quality Objectives for the period of time in which they could occur.

The results of these calculations for nitrogen dioxide concentrations during neutral atmospheric conditions, and intense inversion conditions are shown in figures 1 and 2 which are attached. The maximum calculated concentrations of nitrogen dioxide during plume trapping conditions are .01 ppm at a wind speed of 1 mile per hour; .05 ppm at a wind speed of 5 miles per hour; and .09 ppm at a wind speed of 10 miles per hour. The maximum calculated concentration of nitrogen dioxide during calm conditions is .13 ppm.

The maximum calculated concentrations of sulphur dioxide in the ambient air at ground level are approximately six percent of the concentrations of nitrogen dioxide, assuming the maximum specification limit of 20 grains sulphur per 100 standard cubic feet. This quantity of sulphur, although an extreme maximum, results in calculated levels which are below the limits stated in the regulations. A more probable sulphur content of less than 2 grains per

100 standard cubic feet results in the ground level concentrations being less than .6% of the quantities shown for nitrogen dioxide.

The maximum calculated concentrations of carbon monoxide are approximately the same as the concentrations shown for nitrogen dioxide. However, the allowable limits are 40 to 60 times higher, and therefore the concentrations are well below the allowable limits.

Studies on the effects of sulphur dioxide on lichens which are generally considered the most sensitive plants and the best indicators of SO-2 pollution indicate that there might be acute damage at 0.03 parts per million of sulphur dioxide, some chronic change at 0.006 parts per million, and no damage whatsoever at 0.002 parts per million. This is in a paper by Sidey, Peter, 1975, "Discussion of the Response of Lichens to Atmospheric Sulphur Dioxide with Special Reference to those of the Mackenzie Valley, Canada".

The maximum quantity of sulphur dioxide in the ambient air at ground level is less than .0008 parts per million based on using a fuel gas containing less than 2 grains sulphur per 100 standard cubic feet. This concentration is well below those levels considered to be harmful to lichens.

The applicant is continuing studies on further ways to reduce in particular oxides of nitrogen in the turbine exhausts. We have held discussions with most of the turbine manufacturers which offer equipment for possible use on our system and most manufacturer are presently working on improving combustion chamber and fuel nozzle design to reduce NO_x emission levels. Steam or water injection reduces emission levels and has been considered, but thse methods are not practicable in the Arctic because of the large quantities of demineralized water which are required. We expect to take advantage of the latest technology in combustion chamber and fuel nozzle design to ensure that the NO_x emission levels are as low as is practicably feasible.

MR. CARTER: Sir, here the prepared evidence omits the section on ice fog and continues on the next page with the paragraph, "Routine maintenance...". Following that paragraph we have a new insert for ice fog and that is the last page in the amendments that are inserted in the report.

A Routine maintenance procedures at the compressor stations will result in the release of some natural gas. DUring the startup, during normal unit shutdown for maintenance, or in the event of a mainline break, quantities of natural gas will be expelled to the atmosphere. The low density of natural gas causes it to rise rapidly, thereby making the effects of mainline breaks and ground level air quality only temporary in nature.

Ice Fog. Ice fog is not considered to be harmful to the natural environment but may restrict human activities because of limited visibility. For ice fog to form, large quantities of water vapour along with temperatures below -22°F are required. Between temperatures of -22°F and -40°F an abundance of nuclei are also required for the ice particles to form. Below -40°F the formation of ice particles is spontaneous and does not require the aid of nuclei. The quantity of water vapour in the station exhaust gases will probably be enough to form ice fog, provided atmosphere conditions are right. In areas where ice fog is a problem, such as Fairbanks, Alaska, there is an abundance of unburned hydrocarbons and particulate matter in the atmosphere which originates from automobile exhaust and several coal burning plants in the area. With Natural gas as a turbine fuel, if no other contaminants are present in the atmosphere it is possible that not enough nuclei may be present to form ice fog at temperatures below -40°F.

This appears to be the case with existing compressor stations in western Canada where ice fogs are not commong during these temperatures. At temperatures below -40°F the density and thickness of the ice fog layer will be dependent on the terrain and the degree of stabilty of the atmosphere. It is possible that even during temperatures below -40°F the density of the ice fog will not be high enough to seriously limit visibility.

Noise. Noise levels will be intensive at times during the construction period, but should result in only short term losses in the environmental quality. Applicable construction worker noise exposure standards will be complied with, and the virtual absence of wildlife during the construction period will preclude significant adverse effects on them.

During the life of the pipeline the only important source of noise will be from the compressor stations. Our calculations show that with the noise data whcih we now have from manufacturers and based on operating experience, the noise levels at the station boundaries will range between 60 and 68 dBA. At a distance of 1,000 feet from the station boundaries these levels would reduce to between 50 and 54 dBA. These levels are assuming -- are based on assuming worst case conditions, i.e., flat hard surfaces around the station with no absorption by the ground, minimum absorption by the air and zero wind velocities.

In selecting criteria for

noise limits, we have taken as a guide the Energy Resources Conservation Board of the Province of Alberta, which sets a daytime limit of 65 dBA and a nighttime limit of 50 dBA within 10 feet of any permanently occupied residence. In comparing the noise levels of available equipment having conventional silencing with the diverse requirements of personnel on site, adjacent populations, and wildlife habitat, we find no conflict. A general guideline has been recommended by our ornithological consultant, Dr. W.W.H. GUnn, that average sound levels be limited to 50 dBA at a distance of 1,000 feet from the compressor station. The Alberta regulations require 50 dBA or less within 10 feet of any permanently occupied residence. The noise levels anticipated from the stations meet these requirements.

MR. CARTER: Thank you, very much. Sir, we propose to have the slide presentations when the Inquiry reconvenes.

THE COMMISSIONER: All right, well, thank you very much, Ms. Minning. The Inquiry then should adjourn, should it, Mr. Goudge?

MR. GOUDGE: I think so, sir, until a week from Monday at 1 p.m.

THE COMMISSIONER: All right, the Inquiry is adjourned until Monday, November 3rd, at 1 p.m.

(PROCEEDINGS ADJOURNED)

MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES, and
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.

November 3, 1975.

PROCEEDINGS AT INQUIRY

Volume 79

ALLWEST REPORTING LTD.,
4299 CANADA WAY,
BURNABY 2, B.C.

I N D E X

Yellowknife, N.W.T.

November 3, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, we'll call the hearing to order, and I think we're ready to proceed. Mr. Marshall?

MR. MARSHALL: Thank you, sir.

Sir, the direct evidence of the panel dealing with the impact on the physical environment has been read into the record. Two of the panel members have not previously given evidence. They have now been sworn and I'd like to introduce them and review their qualifications. The first is Mr. Donald Dabbs. Mr. Dabbs is the gentleman sitting here third from the end of the table.

DONALD DABBS, and
PETER J. McCART, sworn:

DIRECT EXAMINATION BY MR. MARSHALL:

Q Mr. Dabbs, to review briefly your qualifications, your present position is as manager of the Environmental Division of R.M. Hardy & Associates Limited. Is that correct?

WITNESS DABBS: Yes.

Q And your education was received at the University of Saskatchewan where you received a B.Sc. in Agriculture in 1968, and an M. Sc. in Plant Ecology in 1971.

A Right.

Q You're a member of the

Alberta Institute of Agrologists, and the Canadian Society of Environmental Biologists, and the International Association of Ecology.

A Right.

Q Your professional experience, beginning with the summer work, the summers of 1961, '62, and '64, you were with the Canadian Department of Agriculture Research Stations at Scott, Saskatchewan and Fort Vermilion, Alberta, in 1965 and '66 in the summers you were at the Saskatchewan River Delta with Canadian Wildlife Service, the work entailing vegetation sampling and air photo interpretation for the development of the landscape classification and vegetation mapping?

A Yes sir.

Q In the summer of 1967 you were with the Department of Biology, University of Saskatchewan, involved in field research program on inter and intra-specific competition between several groups of animals, together with a habitat classification. Is that correct?

A That's correct.

Q Then in 1968 to '70 you did contract research in plant ecology, Peace, Athabasca Delta for the Canadian Wildlife Service?

A That's so, yes.

Q And you were responsible for the development of remote sensing techniques and the application of these techniques to the study of vegetation response and successional changes resulting from the alteration of the hydrologic regime of the region.

Then, sir, beginning in 1971 you became involved with the Arctic Gas project through Williams Brothers ?

A That's correct, yes.

Q And beginning in 1971 you were senior plant ecologist with Williams Brothers. In 1972 you moved over to Northern Engineering Services on its establishment, and then in January of 1974 you transferred to Canadian Arctic Gas Study Limited as environmental researcher. Beginning in December, 1974 you moved to R.M. Hardy & Assoc[illegible] Environmental Division?

A That's correct, yes.

Q And you have to your credit some six publications that are listed in Appendix "A" to your resume, which you will file, sir, and I understand as well numerous consulting reports, in addition to those. Is that so?

A Yes sir.

Q Your area of responsibility initially involved co-ordinating all of the ecological studies, then in March, 1972, you were the senior plant ecologist responsible for the design and execution of the vegetation and re-vegetation studies of the project.

A That's right.

Q Thank you, Mr. Dabbs.

The other member of the panel who has not previously testified, sir, is Dr. Peter J. McCart. Dr. McCart is the gentleman sitting on Mr. Hemstock's left.

Dabbs & McCart
In Chief

Dr. McCart, you're the president of Aquatic Environments Limited, and your education was received as follows, sir: You have a B.A. in zoology from the University of Oregon in 1958; and M. Sc. in zoology from the Institute of Fisheries, U.B.C., 1963; and Ph. D. in zoology from the same university in 1970?

WITNESS McCART: That's correct.

Q Your professional experience, beginning in 1963, is as follows: 1963 to 1968 you were a Fisheries scientist with the Fisheries Research Board of Canada, Nanaimo, British Columbia. From 1968 to 1971 you were a special lecturer and assistant professor of the Department of Biology, University of Saskatchewan, Regina?

A That's right.

Q 1969 to '72, consultant to the Alyeska Pipeline Service Company, Bellevue, Washington, our studies involved work on the life history of fresh water fish in the Sag River drainage in the Alaskan North Slope, an assessment of potential impact of the construction and operation of the proposed Trans-Alaska Pipeline?

A That's right.

Q 1971 to '73 you were an assistant professor, Department of Biology, University of Calgary, and from 1973 to the present you've been president of Aquatic Environments Limited?

A That's correct.

Q Since 1971 you've been consultant to Northern Engineering Services Limited

on the Arctic Gas project.

You have to your credit, sir, the publications that are listed in the appendix to your resume, which I'll file with Miss Hutchinson. There are some 14 publications, and your area of responsibility, Dr. McCart, has been with respect to the design, supervision, and reporting of studies on fish populations along the alternate gas pipeline routes in Canada north of the 60th Parallel and in Alaska.

A Yes.

(RESUME & LIST OF REPORTS OF D. DABBS & P.J. McCART MARKED EXHIBIT 301)

(CHAPTER 6, STATION EMISSIONS, N.E.S. REPORT, MARKED EXHIBIT 302)

MR. MARSHALL: Thank you, Dr. McCart. Dr. Harlan has a couple of corrections sir, to the evidence that was read in the first is at pages 3 and 4 and I would ask Dr. Harlan to correct the record and unfortunately we do not have the transcript for the last day of hearings. I have asked Dr. Harlan if he would make the reference to the prepared direct evidence and then read in the correct wording for the particular passage where the error occurs. Dr. Harlan, could you give me some help?

WITNESS HARLAN: Yes, first of all, in reference to page, or the last paragraph on page 3 in the first five lines of page 4, I would like to read it as it should be corrected. Okay, the corrections relate primarily to the figures given with regard to acreage.

"In addition to the land required for the pipeline right-of-way, approximately 784 acres or 1.2 square miles within the Yukon and the North West Territories will be required for construction of compressor stations. 971 acres or 1.5 square miles for the construction of 66.5 miles of permanent project roads, 2,430 acres or 3.8 square miles for the construction of airstrips and 185 acres or 0.3 square miles for wharfs . In total, the estimated permanent land requirement is 21,947 acres or approximately 34 square miles within the Yukon and North West Territories.

Q · Thank you. The next correction was on page 9 of the prepared evidence. The

correction is on the first line of the last paragraph under "Impact on Resources". The sentence should read the project will require use of 34 rather than 32 square miles for the life of the project and the temporary use of 8.5 square miles of land in the Territories.

It is just the one number that is changed.

A Yes, sir, and the next correction was on page 46, lines 2 and 3. Line 46. On the second line, on page 46, the words "wherever space permits" should be deleted.

Q So the sentence then should begin "A buffer zone will be left between the burrough operation and the stream channel."?

A That is correct.

Q Thank you, Dr. Harlan. Mr. Hemstock has some more recent data pertaining to H_2S, Mr. Commissioner, and I have asked him if he would just make a brief statement that would amplify the evidence that would--that is contained in the prepared direct evidence.

Mr. Hemstock, could you relate the recent information that has been obtained pertaining to this subject?

WITNESS HEMSTOCK: Yes, sir. We have been touch with the three major producers in the Mackenzie Delta Area, and with the ARCO Exxon in Prudhoe Bay. The, in short, the three producers in the Delta Area have found virtually no sulphur in any of the gas samples which have been analyzed. In the

case of Imperial, this is with instrumentation or detection limits down to 0003% by weight. The producers ARCO and Exxon, from Prudhoe Bay say that they have based their information on the analysis for two major sulphur compounds which are H_2S and mercaptans and while they have not run a total sulphur test at this time, they estimate that the total H--the total sulphur of the gas from the Saddlerochit formation should not exceed two grains of total sulphur per hundred standard cubic feet of gas.

Q Thank you, Mr. Hemstock. Sir, I am having that information put on the record as it affects the section of the evidence that pertains to air quality. There is one other matter that pertains to air quality. Mr. Koskimaki was asked earlier if he could provide copies of a report, or at least a section of the report that dealt with station emmissions.

A: That document is now available, sir. We have three copies; if others require copies for purposes of preparation of their case we would happy to have them run off, but I have those available now if any of the Council would wish to pick them up. We can make it an exhibit if it--if that would be best, sir.

THE COMMISSIONER: Well, maybe we should make it an exhibit.

MR. MARSHALL: Fine, sir. It is Chapter 6, Station Emmissions. It is a report of Northern Engineering Services. It is taken from the Preliminary Station Design Mechanical Electrical and Local Control.

MR. MARSHALL: I think, sir, those who look after the few preliminary matters.

There were three slide presentations that the panel wished to make in connection with the evidence that Miss Minning read in when the Inquiry was last in session and I'd like now to proceed to those, if I could before cross-examination.

J.I. CLARK,
R.L. HARLAN,
R.A. HEMSTOCK,
C.M. KOSKIMAKI,
G.V. MINNING, and
G.L. WILLIAMS, resumed:

MR. MARSHALL: The first slide presentation will be made by Miss Minning pertaining to borrow.

WITNESS MINNING: The major uses of borrow material are for construction of permanent access roads, compressor stations, air strips, and other major pipeline facilities. Lesser quantities of borrow are used in drainage and erosion control, slope stabilization and surcharge berm. May I have the first view graph?

Approximately 30 million cubic yards of borrow will be needed for construction of the pipeline and its facilities in Canada north of 60. This view graph shows a breakdown of requirements for major facilities along the coastal and interior routes. Sub-totals indicate quantities in Canada north of 60, No. 9 indicates quantities for the Alaskan part of the route.

Q Just if I can stop you there. This first view graph shows the information in Canada you have seven different segments. You have the borrow requirements for each of those segments, and then a sub-total for Canada north of 60 on the 8th line. Is that correct?

A That's correct.

Q Then you've added in the Prudhoe Bay to the Alaska-Yukon border as item No. 9, and then given a total for the whole system to the 60th Parallel.

A That's correct.

Q I see, and you've given it for both the coastal route and the interior route, either the Marsh Fork or the Canning River options.

A That's correct. As I said earlier, the sub-totals in Canada north of 60 do not include requirements for granular backfill, bedding and padding, swamp and river wastes. These totals are approximately seven million cubic yards for the prime route.

THE COMMISSIONER: Excuse me. Do you mind just repeating that and going a shade slower? You said that we see these totals here, 23 million 513 thousand cubic yards of borrow in Canada north of 60 along the Arctic Gas prime route. What came after that, 7 million cubic --

A Yes, 7 million cubic yards are required for granular backfill, bedding and padding, swamp wastes and river wastes. So the total

for Canada north of 60 is approximately 30 million cubic yards.

Q So that the 23 million represents infra-structure in a sense and the 7 million represents the actual material used in the trench?

A That's correct.

Quantity estimates are an on-going process as pre-construction planning progresses. Estimates for facilities originally based on air photo interpretation and as field evidence becomes more common, these things can change. Permafrost, relief, topography, surface drainage and construction methods are all considered when making the original estimates. The amount of land used in borrow sites numbers 3,928 acres or 6.1 square miles. This represents approximately 40 acres per borrow site, for 98 sites in Canada north of 60. Borrow sites will have some of their area used --

Q Excuse me, 98 sites --

A In Canada north of 60.

MR. MARSHALL: That's shown on this first slide.

A Right.

Q Sir, you see,

"Sub-total Canada north of 60"

under the prime route they have 98 sites.

A Borrow sites are located in surficial deposits in bedrock exposures which occur along the pipeline route. Most favorable deposits are sand and gravel of glacial outwash, and alluvial deposits,

Competent bedrock like limestone can also provide required borrow material when crushed. Finer grained sediments in morainal, glacial,lacustrine or glacial lake and windblown deposits are less desirable than sand and gravel, but can be used for construction purposes.

View graph 2 shows a breakdown of the types of borrow sites found on the prime route with the east of Fort Simpson re-alignment. Wherever possible, borrow sites are located no more than eight miles from the pipeline right-of-way. Preferred and alternative borrow site locations appear on the project strip maps. Section 13-A-2 of the application. Field investigations of both the reconnaissance and detailed nature will be done for each borrow site that is chosen for construction. A reconnaissance program for borrow sites was undertaken from July 12, 1975 to September 21, 1975. This program included geological environmental, geophysical and engineering input; 181 sites were visited on the reconnaissance. Of these 181 sites 106 were studied in detail. There were approximately 10 drill holes and 230 test pits. Emphasis for this summer program was to cover areas which were outside of the Diane granular materials inventory, to cover areas where shortages of granular material exist according to the past inventory work and to investigate areas shown as borrow sites on the project strip maps.

Q If I could just stop you for a minute, Miss Minning. You've got the various types of borrow pits. The first one there is bedrock,

and I guess we all understand that. Alluvial flood plains, fans and terraces, "alluvial" means rivers, does it?

A That's correct.

Q And then glacial fluvial would you explain that?

A Those are rivers associated with glaciation, river deposits.

Q And glacial lacustrine is the next.

A Those are glacial lake deposits.

Q And the next is morainal.

A Those are the deposits associated with the ice, the glacial ice directly.

Q And I take it you will be showing us some slides of these major deposits.

A That is correct.

Q Sorry to interrupt.

A Slide No. 1.

THE COMMISSIONER: Those view graphs should be marked as exhibits.

MR. MARSHALL: Yes sir, I have copies, and I'll give them to Miss Hutchinson now.

(VIEW GRAPHS MARKED EXHIBIT 303)

A I emphasize that these slides show typical deposits. Some of these deposits have been chosen as borrow sites; some have not been chosen as borrow sites, but have been chosen as good slides to show typical features.

Clark, Dabbs, Harlan, Hemstock,
Koskimaki, McCart, Minning, Williams
In Chief

Most alluvial deposits that will be exploited -- would be exploited, will be in the coastal plain area. This particular slide shows two types of alluvial deposits. One is known as the fossil flood plain; one is known as the active flood plain. The lower floorground is the fossil flood plain, it's vegetated, consists of gravel and sand. The background is the active flood plain. It also consists of gravel and sand, it's not vegetated. Within the active flood plain are active stream channels. No borrow would be taken from active stream channels in the active flood plain.

Q Just looking at the upper left-hand corner of the slide, the sort of grey area would be gravel. Those are gravel bars in the coastal river?

A That's correct. This particular slide is taken on the east bank of the Firth River looking north. The location is approximately one mile north of the Buckland Hills. This deposit was drilled and tested in the summer program.

This slide shows two types of alluvial deposits. Alluvial terrace deposits and alluvial flood plain deposits. This slide is also along the Firth River north of the last site. The upper deposit has at least 30 feet of gravel and was drilled this summer too.

Q That's the one in the terrace?

A That's right, the terrace.

Q Yes.

A The en vironmental assessment of each area would decide whether the terrace deposit or the river deposit would be the best to take. These are just examples. The original borrow site in this area was shown in the active flood plain.

Q Now, I take it that the term, "active flood plain" as you're using it, is not the same as Dr. Peter Lewis was using it. You're using it in the N.E.S. definition of the active flood plain, are you? Not the fossil --

A Yes.

Q O.K.

THE COMMISSIONER: I thought you said a minute ago it was not the intention of Arctic Gas to take gravel from the active flood plain.

A From the active river channels on the flood plain.

Q Oh, I see.

A Those are active channels those are active flood plains, and then there is fossil flood plains.

Q Right, so here, just taking the last slide and this one together, on the last one you had an active flood plain and a fossil flood plain?

A That's right.

Q And you would be taking gravel from both, but not from the active river channel.

A That's correct.

Q Now here you have this

terrace.

A It's possible that this could be a borrow site too.

Q Yes.

Q When you said there were 30 feet of gravel there, you meant the active flood plain, not the Terrace.

A No, I mean in the Terrace. It is 30 feet thick there.

Q That is what I thought you meant. Now, the flood plain itself there, you would be taking gravel from that flood plain as well?

A Possibly. We have shown a borrow site in this flood plain in our preliminary work.

I have some slides along Alyeska that show development of an active flood plain, so possibly that will, that will come later in the talk.

This is another Terrace deposit. This is in the vicinity of Fort Simpson. This can be classified as either a glacial, faluvial, or alluvial terrace. No one really knows the age. It has gravel with a silt cover. Glacial faluvial deposits account for the largest number of borrow sites shown on the project strip maps. This particular slide is on the Yukon Coastal Plain east of the Flood Plains sites that were just shown.

Q Perhaps Dr. Clark, you could outline the deposit there.

A In this deposit, there is at least 15 feet of gravel. This was also drilled in our summer program.

This is another outwash

deposit in the vicinity of Yaya lakes on the east side of the Mackenzie Delta.

Q Dr. Clark, again could you outline where the deposit is?

A This is a typical esker in the area east of Inuvik and south of Sitidgi Lake. The slide was looking northwest. The esker is 50 feet high. At present, this esker is presently not a borrow site on our project strip maps but it was a good example of an esker.

This is another example of an esker in Fort Good Hope area.

Q The esker is composed largely of gravel materials?

A Yes. Gravel and sand.

Q And they have been deposited, if I understand the evidence that has been given previously, by glaciers?

A By rivers associated with glaciers. This is a knobby outwash deposit near Rapid Creek on the Yukon Coastal Plain. This site is 8 miles southeast of the confluence of the Bow River. These are came deposits better known as came deposits which is hummocky outwash. They are approximately 50 feet high. These also were drilled and tested this summer. The ridge area is in the foreground also consists of outwash, gravel and sand. This is in the vicinity of Lost Reindeer Lake. This represents an outwash plain deposit in the area south of Fort Simpson near Mile 240 on the Mackenzie Highway. In this parti-

cular deposit there is about 50 feet of gravel over bedrock. This is fine gravel with very little sand or silt. This is a close-up of the pit. This is also a gravel pit in an outwash deposit along the Mackenzie Highway. There is at least 15 feet of gravel there. This is a close-up of the material in that particular pit.

Bedrock can also provide granular--a source for granular material. This particular slide shows tertiary sands and gravel which are very poorly consolidated. This is in the area near the Parsons Lake Repeater Station.

This is another bedrock exposure. This particular exposure is not a borrow site at the present. This sort of material could be of used if it were close to the pipeline, as it is in some places. This is in the Ramparts Plateau, particular slide.

This is also an example of bedrock and bedrock talis that could provide borrow. This particular location is not a borrow site at present but some borrow sites were located in the same type of rock north and south of here. That is near Oscar Creek.

THE COMMISSIONER: Where was that?

A Near Oscar Creek.

Q Where is that?

A In the area near Norman Wells.

MR. BAYLY: Mr. Commissioner,

we have heard about studies that do not appear to be listed in any of Miss Minning's appendices to her evidence. I gather that they were completed last month and I am assuming that we will have the benefit of those and of Miss Minning again if that should be necessary after the studies are produced. They appear to go into areas that she does not list as having studied previous to this summer.

MR. MARSHALL: I take it, Mr. Bayly, you are referring to the joint program undertaken this summer.

MR. BAYLY: That is correct, Mr. Commissioner That is what I was referring to and Miss Minning's material discloses that she had studied in the Fort Simpson area and south and I gathered this summer she also studied at least [illegible] the Yukon Coastal Plain and in the Delta and Parsons Lake Area.

MR. MARSHALL: Miss Minning advises me, Mr. Bayly, that studies were carried out along the length of the pipeline this summer and the report is in preparation. Hopefully, it will be available in January.

THE COMMISSIONER: Well, when that report is available it may be necessary to recall Miss Minning. I do not think that presents a problem.

MR. MARSHALL: It does not, sir

WITNESS MINNING: The view graphs that follow will show some typical development plans. These view graphs are taken from view graphs

which appear in a report that was filed here called "Pipeline Related Borrow Studies." These are typical development plans. It does not mean that these plans will apply to each site. Each site will be done by itself, but these show the four major types of deposit.

This first view graph shows both active and fossil flood plain borrow pit development. The upper left-hand corner shows the plan view of the borrow area. Area 1 is in the active flood plain. Area 2 is in the fossil flood plain. The cross-sections on the right side of the drawing show cross-sections done across lines which appear on the plan view. At this particular site 615,000 cubic yards will be needed, approximately 45 acres is involved-- 25 acres in the active flood plain, 20 acres in the fossil flood plain. This does not mean that this would be what happen at this site. We just wanted to show an example of how it could be done using both flood plains in the same drawing. There are comments on the drawings which pertain to vegetation. I guess you can read that for yourself. I will make some general comments that apply to borrow pit development in both active and fossil flood plain. Before any borrow site is developed in an active flood plain it will be investigated from an environmental point of view. This would include all aspects--fish, mammals, birds. If a site is in an active flood plain, it must be investigated from a hydrology point of view to make sure that the hydrology of the river is not affected and the integrity of the pipeline is not affected. Active

flood plain slides will be at least 2,000 feet from the pipeline.

MR. MARSHALL: I take it in this sketch that is before us that a pipeline is off in the left-hand corner and if I can read it right, it is perhaps not as well focused as it might be. Dr. Clark, could you point out where the pipeline is and then the sites are some distance off to the right from where the pipeline is.

A Yes, there are access roads which appear on that plan too. There is a creek in there too. The borrow would be removed from an active flood plain site prior to freeze-up and stock piled in windrows for recovery during winter. I will show an example of this sort of thing that was done in the Alyeska Pipeline.

THE COMMISSIONER: Excuse me. I just did not catch that. What were you going to do in stacking what up in windrows?

A The gravel from--if an active flood plain site were developed--gravel from the flood plain site would be stock piled in windrows which are long piles of gravel so that they could be used during construction in the winter.

MR. MARSHALL: One of the slides that is coming, sir, shows this sort of operation that was undertaken by Alyeska.

THE COMMISSIONER: I am sorry. Maybe it is because we have been away for a week but I am missing something. What is the significance?

You are removing gravel from the active flood plain and piling it up in windrows for use in the winter time.

A That is correct.

THE COMMISSIONER: If it is--will you be doing that with the other sites as well?

A No, no, this is for flood plains, the gravel will be wet when it is in the flood plains. It will have some water in it. In the winter we have--

Q Will it be wet in the spring?

A Yes.

Q And you want it to dry out. Is that right?

A It dries out better in the piles.

THE COMMISSIONER: O.K., I understand.

A Clearing, there's very little clear on an active flood plain, but overburden removal, if there is overburden present, will be similar to that shown in upland borrow sources, and I will discuss that in a moment.

Fossil flood plain development will be governed by the water and ice content in the fossil flood plain deposit.

MR. MARSHALL: Q Now on this diagram that is before us, the fossil flood plain is area No. 2, is it?

A That's right, it's higher than the active flood plain. It can, because it is higher, it may have more ice in it. It's not under the river or lower areas.

Buffer zone, 300 feet of undisturbed vegetation ground will be placed between an active and fossil flood plain, if a fossil flood plain is developed. Fossil flood plains will be excavated in winter to minimize environmental damage. Blasting may be required in fossil flood plains if they are very frozen. Assessment must be done prior to blasting to ensure that it's done at the proper time from the fish, bird, mammal, point of view.

In both active and fossil flood plain sites, passage of equipment will be limited so that siltation will not occur in the streams and channels. Temporary stream crossings will be installed

and removed before breakup where completion of borrow operations.

This slide shows development of an outwash deposit. This particular one is near Oscar Creek Gap near Milepoint 365.9 on the pipeline. This particular site , 485,000 cubic yards of borrow is needed. 31 acres will be involved. This particular site is vegetated with spruce, aspen and birch, and has one foot of deep topsoil, has some commercial timber, and is a good moose habitat. Any development would have to consider this moose habitat.

This pit will be developed sequentially, as will all the land borrow sites. In other words, the clearing of soil and timber will take place in stages and each stage, each cleared site will be used for stockpiling materials that have been removed. In this particular area, too, care must be taken that siltation doesn't affect Oscar Creek.

Next, a typical esker deposit in the way it would be developed. It also, like the upland borrow sites shown previously, will be escavated in stages. These particular site requirements were 244,000 cubic yards.

Q Just to see if I follow correctly, starting on the left-hand side, you show the esker as a finger or projection.

A That is correct.

Q And then you're showing stage 1 of development at the tip of the esker and the later stages of development you work back to the deposit,

A That is correct.

THE COMMISSIONER: Excuse me, you were here when Dr. Roed gave evidence the week before last, I think, and Dr. -- the two gentlemen that discussed the east of the Franklin route and the edge of the Shield route, do you remember those? Remember that argument about how long the ridges were?

A Yes.

Q Well, I take it that among other things they were talking about eskers, were they?

A They were talking about drumlins.

Q About what?

A Drumlins.

Q Yes.

A And flutes.

Q That's right. How long, without getting into that sort of thing, how long are these eskers?

A They vary in length. This particular esker is quite long, it's over five miles long.

Q Yes.

A Some eskers, most of the eskers are much smaller than that.

Q And that's my impression too, from looking at the country from the air. What -- well this one, this five-mile esker, how big a chunk out of it would you take then to get your X quantity of

cubic yards?

A Approximately eight acres.

WITNESS CLARK: This scale in the scale is wrong.

WITNESS MINNING: In the [illegible] there are corrected scales, I think this particular one was wrong.

MR. MARSHALL: Q Your requirement you show on the slide is 244,000 cubic yards?

A That's correct.

Q And then the item 3 says you need 8 acres for the

A To solve that, that's right.

Q -- borrow site.

A That's right, because eskers are high, it's not often necessary to make as big an escavation. All upland borrow sources, this includes outwash and eskers, and glacial- fluvial terraces, will be examined from an environm ental viewpoint. Buffer zones will be set up between any of these upland borrow sources and rivers. Drainage and erosion control measures will be followed in development of borrow pits. Site plans, which are shown on typical drawings, will also be followed in the field. Timber will be harvested and stockpiled according to government regulations. Slash will be burned according to government regulations, and also according to fire safety. Development in most upland borrow sources will be done in stages. Gravel faces that are left

un -- and not revegetated, will have a final slope of two horizontal to one vertical, or the natural angle of reposive gravel. Where re-vegetated, slopes will be three horizontal to one vertical. In fine-grained material, which might be found in some sites along with the good material, vertical cuts will be left to restore by slumping.

Any vegetation, mineral soil, will be replaced in the pit and spread evenly, then be re-seeded with grass where required, and erosion -- drainage and erosion control measures will be followed and surficial drainage patterns will also be followed.

Most upland borrow sources will be developed in winter months to ensure environmental -- the best time environmentally. If concrete aggregate is to be produced, stilling ponds will be provided in pits where concrete aggregate is produced

Next is a bedrock quarry at pipeline Milepoint 489. Quarry is then limestone or dolemite, and involves approximately eight acres, 315,000 cubic yards of material. There is very little vegetation although the artist shows a few trees here and there. Usually in these bedrock sites there isn't that much vegetation. As with the upland borrow, a buffer zone will be constructed between water courses and quarries. Drainage and erosion control measures will be followed within quarries. Timber removal, vegetation and soil stockpile will be followed in the same manner as in upland borrow sites. Where possible, fractured bedrock, which is often the upper layer on bedrock,

will be used as a source of borrow so that blasting is -- the need for blasting is decreased.

Bedrock quarries will be mined by benches. You can see these on the artist's plan, so that several faces can be worked at the same time. Blasting will be done based on the type of rock, the joint pattern in the rock, field conditions, by environmental conditions. Each site will have to be looked at before a decision as to how to blast the site is made.

The bottom quarry will be sloped to approximately 1%. If, that is if the site is above ground level. If the site is below ground level a pond will be allowed to form in the quarry. Spoil piles will be smoothed out in the bottom of the pits and quarries. Seeding and planting will be done, if required. Stilling basins will be required if the quarry bedrock is to be used in concrete aggregate.

Construction schedule is very important in the development of pits or quarries. Quarries will not be developed at a time when raptors are present. Upland borrow sites will generally be developed in winter. Flood plain sites will generally be developed in winter if they are fossil flood plain sites; and in the fall if they are active flood plain sites.

This is an active flood plain site on the Alyeska Pipeline. Those ridges of material are windrows.

Q Just to help get us oriented, there is a dark line running horizontally at the top quarter of the slide, above that, Dr. Clark, on the other side. Is that one side of the river, one edge of the river channel, or what is that?

A That's one edge of the river.

Q And where would the othe edge of the active river channel be, Dr. Clark?

And those four mounds are windrows of gravel, are they?

A That is correct. This particular pit has been made probably deeper than some pits would be made, and as a result they have water in the pit itself.

Q That's the sort of white-

A Yes.

Q -- bluey-white area in between the four or five vertical strips.

A Right.

Q And the active channel of the river would be above that, would it? And what is in the foreground, Ms. Minning?

A In the foreground is -- I'm told this is a subsidiary channel, I didn't see this particular site, of the river itself, and a road has been built through this channel.

Some borrow material has been taken to build the road from this channel. You can see the marks of a cat in the foreground. There is also a berm here to prevent siltation into the river.

Q So the borrow operations are separated from the active river channel by the berm that Dr. Clark has shown on the slide?

A That's correct.

This is a closeup of windrows of gravel on the Sagavanirtok River.

Q Is that the berm in the foreground, that ridge that we see?

A That's not the foreground.

Q I'm sorry, I thought it was the one near the bottom.

A No, that's not.

Q The berm is up near the top part.

A This is the material on the active flood plain. This particular site has had a channel cut through it, I think Dr. McCart might comment on this sort of a channel and the way it's used.

Q Dr. McCart, could you, please?

WITNESS McCART: Well, in our recommendations we've suggested that such channels should not be constructed unless it's absolutely necessary. This kind of - - apparently what they've done here is put a blade down and produced a small berm on either side. It is not going to be -- I'm familiar with this particular

area on the Sagavanirtok River, and as far as I know there is no spawning of any significance in this area. The gravels are relatively clean, so that moving through there with a bulldozer would not create a major sedimentation problem to either the fish populations or to penthic vertebrates. However, if it were a rather siltier substrate we might have problems with the downstream movement of sediments into spawning areas if it were the appropriate time of year. We would prefer that this not be done. If it has to be done, we would like to be in a position to make recommendations as to how it might be done with minimal damage.

Q If I understand correctly, the slide that's being shown now shows a channel for the river that is a newly created channel that was made by a bulldozer. They simply put a blade through the gravel and created a new channel for the river. That's what creates the little berms on either side. The slides previously shown, the channel had not been disturbed, if I understand it correctly. Simply a berm had been created separating the channel from the area where the borrow was being taken.

A That's correct. That is the method that we would prefer.

Q Could you comment on that method a little more fully, Dr. McCart? I gather you've observed this?

A I think there's another slide coming up which shows what we would like to see

in the way of berm construction, and in the vicinity of active channel.

WITNESS MINNING: I think this is the slide you're referring to.

WITNESS McCART: This is the sort of thing that we prefer. It looks as if the river is coming down from the top, down towards the foreground, and you'll notice that there is a berm encompassing the whole area to the left that is being utilized for gravel. There's no evidence that this has had any effect on sedimentation in the river; we have carried out a reconnaissance of gravel pits along the Alyeska right-of-way and we've learned something from that experience. As I say, this is an example, a very clean procedure as far as gravel removal.

Q Do I understand correctly from the slide that the natural channel of the river continues off to the right-hand side of the picture?

A Yes, and there is a berm, that dark line which surrounds this rather large gravel pit here. There are windrows within the gravel pit, and as I say, there's little evidence that it's had any effect on sedimentation in the river proper.

Q Dr. McCart, from your observation what is the result of such a borrow operation in the succeeding years after the gravel has been taken?

A We've examined similar areas, areas similar to this along the Kavik River in Alaska, and it's very difficult, in fact it's impossible

to detect the presence of these gravel pits in the flood plain itself, you can, if you look along the banks, see where roads have been constructed in some places, to get down. There are still gravel pads remaining, but along the river bed itself there is no persisting evidence of gravel removal, and shifting of gravel from upstream areas, gravel which has been windrowed, or roads and pads that have been constructed in the active flood plain itself are levelled so that really we can't detect these things after a few years, after a spring flood or two has passed through the area.

Q Perhaps you could just comment on what's done on completion of the borrow operation in order that the river can resume its course and so on. What do -- do they leave that berm in place?

A Our recommendation is that as much as possible, gravel removal area be levelled to a level which is at or above that of the active channel, and that the berm be breached so that water can move through the area naturally. What we want to do is avoid ponding, if possible, in these areas.

THE COMMISSIONER: You said that the presence of the berm had not affected siltation in the river, I think you said that.

A What I'm saying is that if you have a berm which prevents the movement of water through the area during the process of removal, then you do have very limited effect on a river. You may have minor increases.

Q During the period when the flood plain is active?

A During the period when the flood plain is active.

Q Now that's the fear, and you say the evidence so far at this site indicates that it's nothing to worry about. I just want to make sure I understand what you were getting at.

A At this particular site there are other siutations along the Alyeska route where there was some indication of sedimentation occurring through breaches in berms. These rivers are subject to some flooding during the summer as a result of rainstorms and things like this, and there can be minor breaches in berms at this time of year. Now I think that this is something that we would want to take into account and ensure ourselves that any berm that we constructed would not only retain water at the time that the berm was under construction, but would be sufficiently high to contain the water during the course of the summer flood. I should point out that turbidity naturally increases, of course, even during the summer where floods occur as a result of rainstorms, so that the additional turbidity would not be as serious as turbidity which might occur during low water periods.

WITNESS MINNING: This is a fossil flood plain borrow site. Notice the organic material and mineral soil has been stripped and stockpiled around the borrow site.

MR. MARSHALL: Again this

would be on the Alyeska project.

A That's correct. This is near Happy Valley Camp.

Q Now the active channel is above this photograph, the borrow area, and there's a berm or an area separating the borrow pit from the river channel?

A That is the spoil.

Q I see.

A This is an upland borrow site. This is gravel and sand, glacial origin. Notice the ponds on the right side with berms to prevent siltation into the creek, that's on the right side of the photo?

THE COMMISSIONER: Where's the creek?

A There's no water in it right now. It could carry water at certain times of the year. Stilling basins.

MR. MARSHALL: There's snow cover here, I guess you can't see any water; and you are saying there's a berm around the --

A Around the stilling basin.

Q -- around the stilling basin to prevent siltation.

THE COMMISSIONER: You said earlier about stilling basins, Mr. Minning, you mention-ed them earlier, without the slide in front of us the significance slipped by. Do you remember what you said?

A Are we thinking of where

there is concrete aggregate stilling basins will be provided? Yes, well, I think that's why I mentioned it before. In other words, where --

WITNESS CLARK: If there was a washing operation and it was necessary to clean this, the water would be collected in the stilling basin. That was the context where it was mentioned before. In this particular instance, though, I don't believe there is any washing operation here. It is strictly surface run-off, and to prevent it from going directly into the stream, letting any sediment allow to settle here before the water enters the stream.

WITNESS MINNING: This is another upland borrow site. It's done in terraces more or less.

MR. MARSHALL: Q Perhaps you could show the berms there, Dr. Clark. Would you just outline them? Do you think you could handle both the mike and the pointer?

WITNESS CLARK: They obviously have provided several areas here for stilling basins at these different berms which were probably constructed as the pit was developed. This is a basin here, one here, and one here. They all intercept runoff which would occur in this direction.

Q If you could just stay with that slide, there doesn't seem to be a pit there. Is that the way these deposits are developed?

WITNESS MINNING: This photo was taken from the air and I am not certain whether that is gravel or bedrock there , being taken out.

Q It looks like it's being taken off uniformly over the whole of the area rather than --

A I'm told that it's gravel. This one was not taken by me.

This is a poor slide, I'm sorry for that, but it's fairly bad weather there often. In this particular case, they're mining talus in the bedrock area. Can you point to that? Can you see that?

THE COMMISSIONER: The talus would be on the cliff, would it?

A Right. No, down at -- that's right, that's right. O.K., next. This is a closeup of that mining operation.

MR. MARSHALL: Thank you very much, Miss Minning.

Sir, the second slide presentation is that of Mr. Dabbs pertaining to vegetation and re-vegetation.

THE COMMISSIONER: Excuse me a second. Could we stop for a cup of coffee? We'll stop for a cup of coffee, Mr. Marshall, if that' O.K.

(PROCEEDINGS ADJOURNED FOR FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: We'll come to order again. Mr.Scott has suggested that instead of sitting this evening, and our usual practice would be to sit this evening, that we should carry on until 6:30 and not come back until 9 in the morning. That's fine

with me, and we'll do that unless there's some great objection.

MR. MARSHALL: That's fine with us, sir.

I think Mr. Dabbs is now ready to proceed with some slides.

THE COMMISSIONER: Fine, Mr. Dabbs. We're all looking forward to your slides.

WITNESS DABBS: Well, I might just say a few words before we get into the slides. The testimony which was filed has appended to it as Appendix "C", a report by Dr. Younkin of my staff, entitled:

"Preliminary Pipeline Revegetation Specifications for Areas North of 60 Degrees."

There's just a couple of points I want to draw to the attention of everyone here.

Q I'm sorry, Mr. Dabbs. That's Appendix "C" -- and just, oh yes, all right.

A One of the things that this report has done in Table 1 is drawn together in the first tabular form, briefly, the results of all of the people that have been involved in this field of re-vegetation research over the past seven years, both in Alaska and --

Q Excuse me, where is Table 1 in that appendix, on what page?

A It follows page 3, of the appendix.

Q Right.

A O.K. I'm often asked whether or not we'd be the only people working on this type of research, and what the findings have been in Alaska or by other researchers in Canada, and I did want to draw this table to your attention, sir, as it summarizes work over the past seven years in -- on the North Slope of Alaska, mostly in the Prudhoe Bay area, and at several locations in Northern Canada, and western Northern Canada. For your own information, the ARCO listing, this is the ARCO Chemical of Fairbanks, Alaska, and we're associated with those people in the early years of the Northwest project in developing the plans for the re-vegetation experimental work at the Sans Sault test site. They are no longer in this type of work. Mitchell et al, Dr. Mitchell is a professor of Agronomy, University of Alaska, and we worked very closely with Dr. Mitchell over the past several years, and in fact Arctic Gas has sponsored a fair portion of his research in Alaska for three years.

The last four locations then, I'm sure you're very familiar with all the names, give a quick and easy-to-understand summation of the results of work done in the Tuktoyaktuk area, Caribou Hills, Inuvik, and Sans Sault and Norman Wells area. I will show a few slides of the San Sault area in a few minutes. Table 2 follows page 11 in this appendix, and I wanted to clarify just a couple of points. This does represent the change from the table and specifications which were provided in the application. I think the most important and the fundamental change to this

Clark, Dabbs, Harlan, Hemstock, Koskimaki, McCart, Minning, Williams - In Chief

table, although we may be talking different varieties than we were two years ago, is the heading,

"Erodability rating."

The importance here now is that these specifications are queued entirely to the work the geotechnical engineers of Northern Engineering who have been developing the erodability rating. Our first attempt at specifications related to [illegible] to soil moisture conditions. Soil moisture conditions are only one of many factors that have to be taken into consideration when determining the potential erosion in any location. That, I believe, is the important change from our first set of specifications. One unfortunate selection of words, is called "sod replacement", I believe this leads people astray to think of sodding in the sense of their front lawn, and I'll show a few slides in a minute to show that it is not sodding in that same sense.

Now perhaps the slides.

MR. SCOTT: Mr. Commissioner, I'm sorry to interrupt, but this all refers, as I understand it, to Appendix "C", which is attached to the transcription of evidence. That has not been red into the record. I'm not suggesting it should be, sir. I wonder if Mr. Marshall could mark a copy of Appendix "C" as an exhibit and tell us whether that is -- represents the latest position of Arctic Gas on these problems, because I am advised that it differs in some material parts from what has been set out in the

application.

MR. MARSHALL: Mr. Scott, I agree it would be a good idea to enter the document -- the report in question as an exhibit, and I'll provide a copy to Miss Hutchinson.

With respect to whether or not it does represent the latest developments pertaining to re-vegetation, I think perhaps Mr. Dabbs ought to answer that.

WITNESS DABBS: It does represent the latest thoughts and it is dated this fall. It is, as I pointed out in Table 1, a summation of all the research available to us and revegetation work in the Mackenzie Valley,Northern Yukon and Alaska and consequently they set a specifications and the basis for arriving at those are our latest thoughts on this matter.

Q This will be Exhibit 304. It is a report entitled "Preliminary Pipeline Re-vegetation Specifications for Areas North of 60°", Northern Engineering Services Co. Ltd., September, 1975.

MR. SCOTT: Mr. Commissioner, I was not apparently quite clear. I am sure it represents the latest up-to-date work but do I understand that this replaces the specifications that are contained in the application.

WITNESS DABBS: Yes, it does.

MR. HOLLINGWORTH: For the purposes of my cross-examination if you would just restate your statement about the erodibility rating that you just made, Mr. Dabbs. I did not quite follow you there.

WITNESS DABBS: I was attemptin to point out the most important fundamental change from these specifications that were in the application to the current set of specifications and that was initially the seed mix combinations were specified in accordance with soil moisture status--dryness versus wet.

They are now tied to the drainage or the erosion estimation, calculations determined by the geotechnic engineers. The erodibility rating then is informatio that is provided to us by the geotechnical engineers.

MR. HOLLINGWORTH: Thank you.

A The important point is the integration of revegetation and the physical drainage and erosion control plans.

MR. MARSHALL: Perhaps, Mr. Dabbs, you could now go on with your slides.

A I believe you have seen a couple of these slides earlier. Les Williams gave you a slide show of the San Sault test site but I want to show a couple again to make the point on revegetation. The pipeline was installed in the winte of '70-'71 It lies directly under these frames here. The fellow in the picture is seeding plants with a hand-operated cyclone seeder. This is bare mineral soil. The black area is organic soil stripped and set to the side there.

Q When was this first slide taken?

A The date here was the spring following construction of the test site. The precise date was June 19, 1971. The point of the next picture then is to show the changes. This is the same test section, the picture previously was taken from this stand of Black Spruce on the hill here. This was taken two months later on August 20, 1971 showing the 20 different plots that were

established over this buried 500-foot section of pipe, all of which have been discussed in full in Volume 2 of the biological report series.

Q Would each plot have a different seed mix?

A 18 of the plots have a different variety or species and they are in pure stands. Only the two end control plots were mixes at the time. The intent here was to determine the performance of the varieties individually at this latitude previous to the work here and the work established at Norman Wells and in the Inuvik area. Even the performance of individual varieties was unknown.

Q And this was taken about two months after the first plot.

A Two months after the test section was seeded,yes.

This is the same test section with the elevated section behind wrapped in insulation now, but it is the same test section in a plot of the Reed canarygrass in the spring of 1972, June of '72. The idea of this picture was to show the amount of top biomass of litters we referred to that has accumulated in one growing season. The interest here is firstly the primary objective of a revegetation program is erosion--surface alluvial erosion control. Secondly, it is one of assisting the re-invasion by native species in the development of a stable actual plant community and perhaps third would be to assist in the restoration of the thermal regime, certainly

revegetation is not going to restore permafrost by itself, but it has a significant influence on the soil temperature and one of the features that controls that is the amount of top materials, the litter accumulation that each variety or species puts down.

We have found for instance that some species grow so rapidly in the first year there is such a heavy accumulation of litter as you see it here that they are unable to survive under their own top growth and unable to produce growth the second and succeeding years. In this case, in Reed canarygrass you can see the new sprouts coming and this particular species is very successful in both providing a thick organic insulative cover as well as continuing to grow itself through its own organic cover.

Q Now this slide, as I understand it, shows the situation the spring following seeding and so there has been one season of growth?

A That is correct. This is the first of the--the spring of the second growing season.

Q This is a picture of another test section. Of course, there are four buried test sections at San Sault. And this is August of the second growing season, and we see here a number of features where there is shallow surface moisture accumulated, very rapid invasion and colonization, mostl Carex aquatilis, Senecio, Juncus. A number of aquatic native aquaticplants, will immediately or within two years establish and within three years dominate in

areas like this one in the foreground where we have a couple inches of water standing.

Q Just to see if I understand you correctly. The three species that you mentioned and I will not try to repeat them because I did not catch them, were not originally seeded there.

A No, that is quite right. This was bare or stripped back. These species have established and quickly flourished here including the grasses along here which were not seeded along the roadway either.

Q Those three species are native to that area, aren't they?

A Oh yes. They are common to this area. Of course, the Carex which I mentioned is very common all the way across.

THE COMMISSIONER:
Yes. Do you know the spelling of each of those for us for the reporters are taking it down and each one as you come to them if you do not mind.

A I think you have me there. How about if I write them out for the reporters. Is that acceptable?

Q Yes, certainly. The point that Mr. Marshall was making, I take it, was that those three species, you did not reseed that area.

A That is the point and those three are only those that are obvious in that particular slide in the tables in the report in the Volume 2 of the Biological Report Series in the report

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of Younkin and Friesen which is a progress report on revegetation which has been filed, I believed. Certainly it is available and subsequent sampling at Sans Sault and all the test sites have looked very closely at the rate and character of invasion by native species into these plots as we, in selecting grasses for seeding, we would not use a variety that continued to grow so densely as to exclude natives.

MR. MARSHALL

Q Just going back to that previous slide, do I understand that you had seeded with non-native varieties at Sans Sault? And the varieties which were seeded on the test plots here are often commonly referred to as agrinomic varities, while they are varieties of species, they are agrinomic. It is a term that is commonly used and often broadly used to refer to any grass species that have been selected through selective plant breeding programs for agricultural or agrinomic utilization. They are, those that succeed in the Mackenzie Valley are almost without exception and there is one exception, they are almost without exception selections made from species which are native to the flora of the North West Territories or the Yukon. For the purposes of explanation here, a variety is a subsection of a species species encompasses a broad range of genetic types. A variety is then a selection within that. And the grasses that were seeded here or the ones that still remain are all those that are genetically related or in fact selections of native species from the northern temperate areas.

Q But there has been in the second growing season evidence of three native species that had not been seeded as part of the re-vegetation re-establishing themselves.

A There's evidence in the reports I mentioned of in excess of 20 species re-establishing themselves.

In the appendix to my testimony, Appendix "C" we were just discussing, we-- and in the application -- we discussed briefly the implementation of the seeding, just how we would attempt to go about seeding the right-of-way, borrow sites, and haul roads, etc. and to this point in time we have discussed the use of aerial application of seed and fertilizer because it has been the intent all along to seed the right-of-way in the spring following construction. There is then no longer a snow road, we have no longer any ground access for the use of wheeled vehicles for seeding either with a hydro-seeder, as was used in Alaska along the Alyeska route, or with seed drills and so forth. This slide is one of a helicopter and bucket, in this particular case spreading fertilizer; in the foreground is the pad, which has been constructed for an oil drilling rig in the outer Mackenzie Delta, precise location, I could give you the rig number, if that means anything.

Q Do I understand correctly that in your re-vegetation trials you've used as test-sites sites that previously were the location of drilling activity in oil or gas exploration activities.

A What we have done since the test sites were constructed at Prudhoe Bay, Norman Wells and Sans Sault, and the research established there is shown in the first couple of slides. We have then taken those findings and prepared specifications or seed combinations for additional research to further test those seed mixes, the proposed seed mixes, or those varieties that have proven successful on the test-sites in a large number of locations, and the rig sites that have been established for exploration in the Mackenzie Delta provided an excellent opportunity for doing this, as it provides us with two things: (1) testing further the varieties of species and seed combinations in a great diversity of conditions throughout the general Mackenzie Delta area, as well as it has provided us with considerable experience seeding disturbances of this type in remote locations, the problems of logistics, the aircraft, getting the right seed and fertilizer on site at a distance of 50 to 100 miles from Inuvik, for instance. To date we have expanding our experience from the test sites to a total of 21 rig sites covering a total of 120 acres of land area from sites in the Peel Plateau in the Mackenzie Delta proper, the Caribou Hills, and I'll show in a minute some sites in the Parsons Lake area.

I think that's enough for that slide. The intent is just to show the seeding.

This particular site is one near the Trail River on the Peel Plateau, which was taken in August of this year. It was seeded in early

June of this year.

Q This had been a rig site?

A This had been a rig site as well,yes. It had been seeded with a helicopter and bucket, and fertilized as shown in the previous slide. The importance of some of this work has been to provide us with test sites in areas that previously had not -- we had not been able to examine in the same manner as the Norman Wells and the Sans Sault test sites, we were down relatively close to the river. We wanted to know just what the performance of these varieties would be at elevated exposed sites as there would be along the lower foothills of the Richardsons and part of the Peel Plateau, we -- the route touches on near Fort McPherson. This is one example, one of those 21 sites.

I'd like also to mention that the seeding of rig sites started three years ago, so we have built up a number of sites of varying ages. This is a shot of a site near Parsons Lake May 28th of this year. As you can see, the lakes are just opening up. The snow had really just receded from this site. It had been cleaned up and abandoned.

The next slide, please, is the same site then, August 20th, 1975, as well.

Q: Now this had been re-vegetated using the techniques shown in the slide with a helicopter and bucket.

A That's quite right, yes. The intent of the slide is simply to show a couple examples of before and after within one growing season, and as you can see, on these well-drained -- here's the

pointer here -- well-drained pads which have a considerable quantity of gravel in them through here, there is relatively little ground cover to the establishment of grasses. If the gravel content is too high or it is too well drained, you get very little growth of grass; but in those cases also you're dealing with non-erodable soils or soils in a situation that are not easily eroded, as on the flanks here where the moisture conditions are better, and would be subject to erosion, you get considerably more growth of grass.

This slide was taken June 2nd, and it's another one back near the Caribou River on the Peel Plateau, and the next slide shows that same site on August 22nd of thisyear. In this particular case you can see the grass that has established is in the foreground at least, and is part of the site. It's name, timothy, which is included in the revised set of specifications.

Q Were this slide and the previous one taken during the same year?

A Yes, they were. The previous one was June 2nd of thisyear. This is August 22nd, I believe, of again this year.

Before I get onto that next slide, I would like to point out also in the last chapter or last section of Appendix "C", we have now recommended that most if not all, most of the seed and fertilizer be applied in the wintertime, as a last operation following right-of-way cleanup. We established

some plots near Tuk last winter, winter of '74-'75, on sites that had been prepared by tearing them up with a ripper tooth on a cat, and they were seeded in the dead of winter, and we were able to get equally good growth of grass from the winter seeding.

The idea of aerial seeding with helicopters, however, is not replaced by this. We're simply speaking in that appendix of applying most of the seed and fertilizer in the wintertime as we have much closer control over the placement of seed, but more important than that, a closer control over the combination in a seed mix. With an aerial application you face a situation where you simply cannot change the seed mix every hundred yards or so because you're applying it in one sweep with an aircraft, either helicopter or a fixed wing, and consequently you have to provide a greater diversity of a species in that mix because you're dealing with a broad diversity of conditions. With the ground base seeding, the variety combination in any seed mix can be easily controlled, it can be changed every ten feet if you want to. There would be no point to that, but it could be that closely controlled. That would be followed in the spring then with just a light dressing of an aerial application on the areas that would require it, in conjunction with the hand operations implementing the special erosion controls on slopes and approaches to streams.

Q Do I understand correctly Mr. Dabbs, there has been a development then in your plans as to when the re-seeding would be done? At the

time the application was filed you were intending that the seeding would be done through use of helicopters and aircraft, and you're now proposing that much of the seeding would be done in the winter.

A At the time that the application was prepared, we simply didn't have the evidence to support my thoughts, which date back many years, that a winter-base operation would be a very beneficial undertaking, and we now have that evidence to support my thoughts on this matter.

Now, this diagram comes from the application, Section 13-A-6, simply a cross-sectional view of the right-of-way. The important point here is that it shows that the tundra material, surface material which would be stripped from that ditch line, would be set aside separate from the spoil mound to be placed back over that spoil mound when it's put in on top of the pipe. This concept was first developed or first conceived in a program I initiated near the Firth River in the spring of 1972.

[illegible] that time I found a site, and we can move to the next slide, which was a reasonable simulation, I felt, of the idea of mechanically peeling off the surface organic layer in tundra regions and placing it back over the backfill mound. In this case I found a seismic line which ran from the foothills right to the coast, where it had obviously been made with shoes on a blade, which held it high enough that it did not peel off all the organic material down to mineral, but low enough to peel all the tussocks of cotton grass, as you see here on both sides of this line, and pile them in a mound in the middle. This was the middle of June, 1972, when this picture was taken.

Q Could you just lay your pointer along the middle of the seismic line in the [illegible]

A Right through here.

The outer edge of the affected area is right here, where you can see the tussocks of cotton grass over here completely undisturbed, knocked off [illegible]

[illegible] re-establish, re-root, and provide a growing [illegible] as well as an insulated cover of the organic, organic material which was placed also in that [illegible]

[illegible] and I seeded those and fertilized [illegible] each plot. At the time I was here, these [illegible] ose, all these tussocks were loose, they [illegible] kicked around.

Q Now do I take it that you consider that this simulates what you envision could happen during construction with the tundra being stripped and then put back in a pile over the ditch mound?

A This is the best simulation of the idea that I could find.

Q Without yourself getting out and ripping up the tundra.

A Without myself taking equipment out on the coast. We have this past winter, only two weeks ago undertaken what I would consider a much more scientific approach to this, and established plots near Tuk where the tundra material was peeled back with a dozer blade in three different locations representing three different tundra community types, and placed back. But this was exploratory in nature and it was my first indication that the concept was perhaps workable.

The next slide then shows that same area, late August, 1974. Here is the plot of red fescue that was seeded, and in amongst it is all the cotton grass which is re-rooted and continued to grow. There is a section in Volume II of the Biological Report series, that show a couple of pictures of this test area, spring and late summer of 1972 showing the root development which [illegible] grass. This material was not in any way placed upright, if you wish, by hand. Consequently some of it doesn't re-establish; but most in the order of 60 to 70% of all

this cotton grass tussocks re-rooted and continued to grow. Many other species were obvious in there also that continued to grow, including the low Arctic willow. The test that has been established at [illegible] will be of more value in terms of quantative data. This, I think, simply illustrates the concept and this is what I mentioned was an unfortunate selection of terms in that spec sheet when we referred to it as "sod replacement" because it is not sodding, preferably the material would be broken up into chunks about the size of a cottongrass tussock, or slightly larger, and it would be peeled off from the ditch line itself, set aside, and placed back over the backfill crown. So obviously some materials that come from a seven or eight-foot ditch line is not going to cover a 12 or 15-foot backfill mound entirely, and that's one reason why I would not want it sodded in an intact piece. I would prefer to have the material spread over in order to provide the plants for establishment over the entire route.

One other point, I believe thi has a real benefit to it, is that caribou, of course, at the time this picture was taken probably migrated back and forth across here at least six times over thre years, and numerous tracks were obvious. But by this combination of natives and seeding, it obviously reduces the attractiveness of this to caribou because we have not experienced the same problems that pier plots at Prudhoe Bay have had where the caribou simply descend and eat them bare. I believe this then

would aid in at least reducing the attractiveness of the right-of-way to caribou.

One point before we move on from this, tundra replacement, stripping and replacement is intended only as a supplement to seeding. Seeding is a basic re-vegetation technique. This would be a supplement to that.

Just one last slide then, we mention one technique for providing additional plant cover on slopes, particularly in approaches to streams and rivers where the material is available, and that is the planting of shrub cuttings, these willows, the cutting as you can see was about that long. This was new growth. Those were planted in the spring. This picture, I believe, was 1972, and this picture was taken the end of August. This was one growing season anyway, that amount of new growth. On cuttings that were not treated with hormones in any way, simply hand cut and placed in the ground, they root and continue to grow, thus providing or re-establishing the native willow cover on slopes which aids further erosion control.

Q That scale shown is in tenths of feet, is it?

A Yes, it is.

Q Thank you, Mr. Dabbs.

THE COMMISSIONER: The scale is shown in tenths of feet?

MR. MARSHALL: I'm told it's an engineer' notebook, and the one to six shown there are tenths of feet.

It's half-way attempt to go metric, I think.

Sir, Dr. Harlan has prepared a slide presentation for icing, and perhaps we could move onto that.

THE COMMISSIONER: Fine.

WITNESS HARLAN: The term "icing" is used to denote several common and very wide-spread phenomena which are characteristic of many cold regions. Its meaning, therefore, depends mainly on the context in which it is used. In its most common usage, the term "icing" is applied to a mass of surface ice formed during the winter by successive freezing of sheets of water that seep from the ground from a river or from a spring. The equivalent terms for "icing" in German, that is aufeis , and in Russian, naled.

MR. MARSHALL: Perhaps you could spell those.

A Aufeis is A-U-F-E-I-S. The term naled, N-A-L-E-D. O.K., these terms are also in common usage in North America. These terms, however, have the connotation of being more restrictive than icing. For example, many North American workers consider aufeis to only include river icings, whereas icing per se includes both river icing and ground icing. The distinction between these will become more evident as we go on.

Icings formed by the freezing of ground water discharge and also water forced to

the surface from the unfrozen zone beneath the seasonally frozen ground and underlying impervious layer which is commonly permafrost, are referred to as ground icings.

Although ground icings most frequently form in the early part of winter, their development can occur whenever the ambient temperature are below freezing and water is made available at the ground surface. For the most part, ground icings present more of a nuisance than a real environmental [illegible]

May I have the first slide, please? The first illustration -- the first slide illustrates the typical ground icing situation. This slide was taken on a tributary to the Rat River at approximately Milepost 390 on the interior route. The slide illustrates seepage that is occurring from the active layer at the river bank.

Q Dr. Clark, can you point [illegible]

A The second slide, if I [illegible]

THE COMMISSIONER: Excuse me, [illegible] uld be ground water from the active layer?

A That is correct, yes. [illegible] slide illustrates what perhaps is more properly [illegible] led a river icing, but for the point of this [illegible] t's more typical of the ground icing [illegible] ation. The icing is located on Canyon Creek, which [illegible] bout ten miles south-east of Norman Wells. [illegible] which is close to a half-mile in total length

developed within a period of 24 hours, causing disturbance to snow cover across the stream bed.

MR. MARSHALL: Q What happened there?

A Now this one was initiated by a moose. This is the best I could determine. He crossed over the stream bed, broke up the continuity of the snow cover, and the insulating value, and forced the water to the surface due to freezing. The development of this progresses backwards, or up-slope.

River icings, on the other hand, formed by the freezing of overflow water which seeps under the river ice cover. A river icing is fed by water emanating from the river itself, or from the pervious alluvium of the river bed. The occurrence of this type of icing is common throughout most cold regions, particularly in areas where there is any kind of relief. Icings of this type can cover extensive areas, as shown by the next slide.

This slide shows an icing developed on Joe Creek, which is a major tributary of the Firth River. I believe some of the icings in this area will extend up to about 15 miles in length. Joe Creek and the icing illustrated are fed by a group of springs about a quarter of a mile east of the Yukon-Alaska border. Discharge from these springs is sufficient to maintain an open water lead in winter of about two miles long. The temperature of the discharge from these springs is about four degrees centigrade, which will give you some indication of the

volume of water involved.

Remnants of the larger icings, particularly in mountainous areas such as the British Mountains, persist throughout the summer months into the next winter. The persistence of aufeis is illustrated by the next slide.

Shown also is the aufeis field on Joe Creek, where as this particular photograph was taken in early summer, it does serve to illustrate the persistence of the ice aufeis fields throughout the summer months. The thickness of an aufeis deposit can be three, four, or even more times greater than the thickness of the ice cover that would normally form on deep lakes and on rivers. The great thickness of ice that can be accumulated over a single winter season is illustrated in the next slide, which shows an icing on the Satarochette River in Alaska. For obvious reasons the development of large icings or aufeis deposits is associated with areas of significant ground water activity, and with streams fed by some of the larger lakes.

On the proposed Arctic Gas Pipeline route, two areas of significant ground water activity have been identified. Both of these areas are characterized by the widespread occurrence of springs, open water leads in winter, and the occurrence of numerous and often extensive icings.

Q What's an open water lead?

A It is an open water breach

in the river over the winter. We'll have a slide of several of these. The first of these areas is situated along the flanks of the Norman Range of the Franklin Mountains between the Donnelly River at about Milepost 317 and the Willowlake River at Milepost 606. Springs in this area vary from fresh to very highly mineralized. Electrical conductivity in excess of 300 micromoles per centimeter have been measured. These very high electrical conductivities and the high degree of mineral ization would suggest that these springs are in an area of regional ground water discharge. For these springs the source of the water is most probably to the west in the Franklin Mountains, that is to the west side of the Mackenzie River.

Water temperatures at the mouth of the springs are also variable, ranging from close to zero degrees Centigrade to a high of 18 degrees Centigrade, measured at a spring in the vicinity of the Ochre River. The occurrence of icings in this area, although wide-spread, is less extensive than along the Arctic coastal plain, which is the second major area of significant ground water activity. Icings along the flanks of the Norman Range are in general confined to the river valleys in which they occur, as illustrated by the next slide.

This slide shows an icing on the Donnelly River, the Donnelly River being east of San Sault Rapids.

The next slide shows a similar type of icing on Prohibition Creek.

In general, potential problems due to icing occurrence and due to chilled pipeline operation are less severe along the Frankln Mountains than along the Arctic Coast. This is due in part to warmer environment andthe confined nature of icing occurrence.

The second area of significant ground water activity and also the most important environmentally extends eastward along the Alaskan and Yukon coastal plains to the vicinity of Shingle Point at about Milepost 290. Within this general area, particularly within the mountainous areas to the south of the proposed pipeline route, several major springs have been identified by Northern Engineering Services and its consultants. The discharge from these springs is typically fresh to moderately fresh, with temperatures in the range of zero to four degrees Centigrade.

The next slide shows one of these springs. This one being the spring on the Canning River in Alaska. This can be considered as typical of many of the springs in the British Mountains.

On the proposed pipeline route itself which traverses much of the Artic coastal plain, the occurrence of icings is extensive and can be illustrated by the next slide. May we have that, please?

This slide shows an icing on the Firth River which extends from about three miles up the pipeline crossing, across the pipeline crossing to the Arctic Coast.

The next slide shows a view

farther down. In the background is the Beaufort Sea. The occurrence of springs and also icings is not confined to the mountains or even hilly areas, but both features occur along the distal or coastal edge of the Alaskan and Yukon coastal plains.

The next slide shows an open water lead, referred to earlier, that was observed in March of 1975 in the vicinity of Craig Creek, which is close to the Alaskan-Yukon border. To the west of this open water lead, the surface of the icing is heaved in very large amounts, such as is illustrated by the next slide.

Water in what appeared to be very substantial quantities, could be heard flowing beneath the ice. At the time this photograph was taken in late March, icing development was still occurring in the sense that locally water was flowing out over the surface and freezing. This process, combined with the heaving of the ice surface, resulted in some interesting, or most interesting features, as is illustrated by the next slide.

Several of the major springs and associated open water leads on the Yukon coastal plain have been identified as important fish overwintering areas. One of the more important of these is the spring shown in the next slide.

This spring is located between the Firth and the Malcolm Rivers at about 1 1/2 miles downstream, or to the north of the proposed pipeline alignment. This spring itself supports a very large

[illegible] scaping nitrogen gas. Although the source of the [illegible] grees Centigrade, and the water is relatively fresh.

It is with regard to areas [illegible] ned drilling and geophysical program in the area [illegible] information [illegible] d water and temperature conditi[illegible] [illegible] entified where the operation of a [illegible] chilled gas pipeline could affect the water [illegible] for over-wintering fish populations, Arctic Gas [illegible] ernative techniques under [illegible] against any detrimental effect [illegible]

insulation around the chilled pipeline to inhibit frost bulb development.

Q Dr. Harlan, if I could just stop you there, do I understand that your program would, among other things, determine what the source of the water was for the springs, such as the one as shown in this slide?

A That is correct, yes.

Q And I take it the source could either be a very deep one, which perhaps might not be affected by a pipeline, or alternatively, it could be ground water.

A It could be shallow water.

Q Shallow water.

A For example, in an unfrozen thalweg that is quite close to the surface.

Q I see.

A O.K., if that is in fact the source, then there is a possibility of freezing off this water, if appropriate measures are not taken.

Q And that gets to the measures you were just discussing.

A Yes, that's correct. I might add that both of these techniques have the greatest affability and potential effectiveness in areas with significant convective heat transport, for example that associated with significant ground water activity. In summary, I would like to emphasize that

the natural occurrence of ground spring and river icing is widespread. These icings, furthermore, can be very extensive aerially and at considerable depth. For example, three, four, or even more times greater than the thickness of ice cover that would normally form on deep lakes and on rivers under similar climatic conditions. In my judgment, the initiation of an icing per se does not constitute a detrimental impact on the environment. It is only when the initiation of an icing on the pipeline route could interrupt the downstream waters applied to overwintering fish populations, or where the initiation of an icing at a pipeline crossing could accelerate channel migration and induce bank instability problems is there a potential adverse environmental impact. Arctic Gas has previously stated its intent to deal constructively with each of these problems.

MR. MARSHALL: Thank you, Dr. Harlan. Mr. Commissioner, that concludes the presentation of the direct evidence of this panel and they are available for cross-examination.

THE COMMISSIONER: Well, let us stretch our legs for five minutes and then we will begin cross-examination. Is that all right?

MR. MARSHALL: I perhaps should point out that both Mr. Dabbs and Dr. McCart will be on the panel dealing with the living environment, sir. We are trying to keep within the rulings to separate the physical and the living environment. Their presentations on this panel have tried to restrict themselves to the physical environment and they will be back again next time around as well.

THE COMMISSIONER: Well, we will just stop for five minutes.

(PROCEEDINGS ADJOURNED FOR FIVE MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. MARSHALL: Mr. Commissioner, Dr. Harlan had a minor correction that he would like to make to his testimony. Dr. Harlan, could you just deal with that now please?

WITNESS HARLAN: During the prepared statement, I was speaking of the phrase that are typical of the flanks of the Franklin Mountains. Many of these are fairly warm, as high as 18° and quite highly mineralized I misspoke and said that the origin of this water was in the Franklin Mountains. It is in fact probably from the Mackenzie Mountain rather than

the Franklins.

THE COMMISSIONER: This was on the west side of the river.

A Yes. That did not ring true at the time but I thought I must be, I did not want to display my ignorance once again.

THE COMMISSIONER: Well, that is a minor correction.

MR. HOLLINGWORTH: It does not radically affect my cross-examination.

CROSS-EXAMINATION BY MR. HOLLINGWORTH:

Q Ms. Minning, on the second slides that you showed, you have a figure of borrow pits from alluvial flood plains, fans and terraces from Station MO4 to, but excluding ME13 of 5. Is that correct?

WITNESS MINNING: That is correct.

Q And, I think I am correct in saying that approximately from Travaillant Lake down to Fort Simpson where the line would leave the Mackenzie River.

A That is correct.

Q Have you pinpointed the exact location of these borrow pits at this time.

A These borrow pits appear in the report "Pipeline Related Borrow Studies." And all of them are in this report and they are described in a chart.

Q All right. Now the berming that you have pointed out as being used by the

Alyeska Co. Are you planning to employ that on these five sites?

A I think that most of those sites are actually alluvial fans or terraces. There is no, to my knowledge, there is no active flood plain sites in that stretch of pipelines.

Q Could you find out and let me know if there are any?

A Certainly.

MR. MARSHALL: I am sorry. Just to make sure I have got your point. You wanted to know whether there would be berms?

Q I want to know if there-- my understanding of Ms. Minning's answer was that there would not be berms because there were no active flood plain sites among those five. Is that correct interpretation of your answer?

A That is correct.

Q And Miss Minning was to find out for sure if there were any or not on active flood plains.

Mr. Dabbs, in Appendix C which is the revegetation program of Arctic Gas, there is an appendix to that that has the common and scientific names of grass species mentioned within this report. I just wonder if we could right now clarify that whenever I use an English expression and I am referring to the Latin genus and species you have on your list. I think this covers most of the species that we will be referring to. Is that satisfactory?

WITNESS DABBS: I am sorry I did not really get the point you made.

Q You are aware of Appendix 1 and 2 plus Appendix C.

A Yes.

Q Could we just establish that whenever I refer to an English name that I in fact mean the genus and species that you have corresponding on the right-hand side of your table. And I have handed a copy of this appendix to the reporters for their use so maybe you do not have to write as much as you earlier promised to do.

Could you turn to Table 2 of Appendix C please Mr. Dabbs? That is just following Page 11 of the appendix, Mr. Commissioner. Do you have that?

A Yes, I do.

Q Now, as I understand it, and the printing is not quite clear on the side but you have divided the route into three zones, that is to say, the low Arctic tundra, the forest tundra, and the boreal forest. Is that right?

A That is correct.

Q I wonder, can you give me the geographical cut-offs of each zones where one turns into another?

A Okay. In the text, it was referred to Rowe, 1972, Forest Regions of Canada, if you want to refer to a map that actually shows you the boundary lines. But for explanation here, realizing that

this particular project does not affect or touch upon areas of any high Arctic that refers to the Arctic Islands. Low Arctic then refers to any of the Tundra regions in the north slope, Richards Island down to about the Inuvik areas just to the south and east of Inuvik and you get into an open forest lichen Woodland. That encompasses the low Arctic area.

THE COMMISSIONER: Inuvik is sort of the cut-off.

A Inuvik is very close to the boundary line between the tree line and tundra. In fact, on the hills above the town, of course, you are int tundra along the warmer environment where the river is still within the tree line.

Then the forest tundra and for clarification here it is often confused and it is a matter of definition more than anything conflicting. Forest tundra is the region of open canopy boreal forest as referred to by Rowe or forest tundra transition as referred to by Hernandez and Bliss in the E.P.B. F.P.B. Report if you consult the map in their little brochure on "What about the Vegetation?". I think again that shows you a very nice map of the broad regions. That then would include the area of the Mackenzie Valley from Inuvik south to Norman Wells. That area generally is referred to in Rowe's map as Lower Mackenzie Section of the boreal forest. It is that region then from Inuvik to about Norman Wells, and then of course the boreal forest is from Norman Wells south.

Q Okay now, this technique

of sod replacement which I think you said was really misnamed appears by Table 2 to be used in medium and low erodibility areas in the low Arctic Tundra regions. Is that correct?

A That is correct.

Q And in no other regions along the line?

A No. At this point in time, we have no evidence to show that the technique would be useful within forested areas, and we believe it only applicable to the tundra region.

Q Why are you only using it in the medium and low erodibility zones?

A If you check under the column Seed Mats, Seed Mats Erosion Control Mats for which I really did not display or discuss before is a much more intensive technique for control of erosion on slopes greater than about 5° or 3°, I believe the report says. In those areas certainly defines high erosion potential such as approaches to rivers and streams, we would use then the seeded mats or mats plus seeding as this is an area that we must be sure of complete control of surface erosion and we would go to that more intensive technique.

Q Okay now, I understand with this sod-replacement technique that you are going to take off about 18 inches of tundra. Is that, do I understand your evidence correctly?

A 12 to 18 inches. I dare say that the thickness of organic material is variable

with site, exposure and type of community but you are correct.

Q I think your evidence says 18 inches, doesn't it?

A 18-inch is fine, yes.

Q That is on Page 8 of your direct evidence i.e. you want the reference? On the second line. Are you now saying that it would be 12 to 18 inches or is it 18 inches?

A 18 inches is fine, I think in actual fact, there are areas in the Tundra where 18 inches would put it a little deep.

MR. MARSHALL: The wording used was approximately the upper 18 inches.

Q Approximately 18 inches would not go down to 12 by my definition. I just wanted to clarify that. Why did you arrive at the figure of 18 inches or how did you arrive at the figure of 18 inches?

A It is important if you wish to make the point on this 18 inches business, that it is approximate, that it would be the total depth from the very top of a tussock to the base of the organic material that we would physically strip.

Q Help me along here. Do you mean the top of the plant grows down to the bottom.

A Well, it is impossible to define to a precise inch measurement because of the microtopographic relief between tussocks of cotton grass and the areas between the tussocks, the maximum

depth would be from the peak then if you wish of the tussock or mound to the base of the organic material which puts it very close to mineral soil.

Q Are you going to go any deeper than the roots of this plant life?

A The 18 inches would probably take it below the roots, would take it into the dead accumulated organic material which is the principle insulation, if you wish.

Q What is the actual method of stripping this tundra off, Mr. Dabbs, that you are proposing?

WITNESS DABBS: At this time, of course, I can speak only to the biological feasibility of it, and the desirability of using the technique. I believe the trials we've had to date have demonstrated to us that there are benefits to using the technique. The technique we have used in experimental plots has been one of simply using a D-7 cat, which is not a large cat, the blades are at an angle and before frost penetrates the permafrost table, a cat of that size can quite easily walk along and peel this material back. In actual fact of construction, I don't believe we have established the technique to be used on a full construction basis. There are a number of options, however, which are open. One would be the use of a backhoe that would peel the material from the ditch line, which of course will be actively surveyed at the time; or if this cannot be used for one reason or another, certainly a pilot ditch can be run with a wheel-ditching machine.

Q When you speak of peeling it off with a backhoe, that sort of is like the sod from my front lawn, it seems to me, that sort of technique; are you actually peeling it off in a layer like that, or does it come off in lumps the way you showed it in your slides?

A It comes off in lumps from that size to perhaps two feet in diameter, or the size of the bucket, if you are using a backhoe.

Q I see, and how would you put it back on after you've finished your pipeline

construction?

A The technique has certainly not been established, as that's a construction question I can speak only to the options that I think are open at the moment. The material would be set far enough aside, if it's not covered with the spoil it could be picked up with a backhoe, a small dragline as they use in backfilling pipelines in the south, or with a Mormon board, and simply pull it over and drop it on top.

Q Sorry, what did you say, a Mormon board?

A Yes, that's a pipeline phrase I just picked up.

Q Can you explain it to me, please?

A It's simply a wide shallow bucket on a dragline that's specifically designed for picking up the spoil and returning it, and dropping it into the ditch.

Q So you wouldn't use hand to do this?

A No, that wouldn't be the intent, not for the most of it. I would foresee the possible need of some hand treatment of turning larger pieces /upright but again you would never attempt to get all the pieces nicely placed upright.

Q Now, would you agree that a correct definition of "agitated propogation" is a method of propogating, using parts of plants other than

seeds.

A That's accurate enough, yes.

Q And are you going to use any other vegetation measures besides the sod replacement and the seed mats and the low tundra in the low Arctic tundra region?

A On very rare occasion, on streams where material is available we possibly would go to the use of willow cuttings as shown in the last slide. Those are very limited, of course. The number of streams that have a willow growth on the side slopes, so the two techniques you mentioned would be the principal propogation ditching.

Q Now are you using willow stem cuttings when you speak of willow cuttings?

A Yes, either hard or soft stem cuttings work perfectly well with willows.

Q Well, I assume that the purpose of this technique is to obtain deeper root penetration and inhibit erosion as much as possible on stream bank crossings. Would that be right, on stream banks?

A That is the major reason, of course, is the deeper root and of course the woody nature of the plant cover as opposed to the soft body of grasses which --

Q If that's your purpose, wouldn't it be better to use a root cutting rather than a stem cutting?

A Root cutting requires that you have a nursery to establish these in, to hae them rooted, as you say, and the technique is possible but very time-consuming and unnecessarily expensive in the light of our results, where the materials are available on-site, simply takes some in, and knives and machettes, and you can prepare all the material you need and obtain 90 to 100% rooting sets with the willows, so it's shown to be unnecessary to go to a root cutting.

Q You wouldn't think that a rooted cutting would be more effective?

A It's difficult to be more effective than 100% success.

Q Wouldn't a rooted cutting obtain a deeper root penetration in the first year than a stem cutting?

A The material that we planted and dug up provided root penetration for most of the active layer and again I'm not arguing in opposition to a root cutting, but what I'm saying is we can obtain the same results from a stem cutting.

Q Well, are these results of yours contained in one of your reports that you've mentioned?

A The first results are in the Biological Reports, Volume II, first photographs. I believe in the report, progress report re vegetation by Younkin & Friesen, and certainly the result -- I know the results of subsequent measurements are being

incorporated into another progress report on San Sault re-vegetation which is in preparation.

Q When do you expect that report to be out?

A I would expect before Christmas.

Q Would your counsel undertake to provide me with a copy?

MR. MARSHALL: Yes.

MR. HOLLINGWORTH: Q Now as I understand Arctic Gas' program is going to use basically agrinomics, varieties or species of plants rather than native species, is that correct?

A That's basically correct. Yes.

Q What's not correct about it then? Your qualifying your answer.

A The native species have been part of our experimental work for the past three years, We've had a major program for experimental studies in multiplication of several of the native species, so it is our intention to include them when it's proven feasible to do so, and at this stage do you recall the specifications in the application we did name the fact that there would be native species in the appendix to my testimony here, There is a short discussion indicating that they have been removed temporarily until proven that they can be produced in quantities where suitable for pipeline re-vegetation.

Q Would you prefer native

species if you had your --

A We would prefer to include them, yes.

Q Include them in what proportions, though?

A Of course that subject for experimentation to determine precisely how and when to use them in association with the faster growing commercial varieties, if you wish, or economics, and at this point in time those data are really not available.

Q Do I understand you then to say that your program would include agronomic varieties in any event, no matter how successful you were in growing native species? Or varieties?

A Yes, the work that was done by Dr. Younkin while with the University of Alberta under the direction of Dr. Bliss in the reports to allure have proven quite conclusively the need for agonomic varieties to provide for quick initial erosion control. The native species, the pioneer species simply do not establish rapidly enough to provide erosion control in short-term.

Q But the agronomic species do?

A They've been shown to do that, yes

Q I think in your deficiency letter No. 7 to the National Energy Board in fact you've

made that case, have you not?

A Yes.

Q Well, can I refer you to the Mitchell & Kendrick Report of February 10, 1975?

A I don't have it before me.

Q Do you not have it with you?

A Not with me, no.

Q Are you familiar with it? I only have the one copy of the chart with me.

A I'm familiar with the report. I certainly couldn't recall details.

Q All right, well I'm referring to Table 7 of that. That's on page 24 of the Mitchell & Kendrick Report of February 10, 1975, and I'll have a copy of this produced and as I understand it, this chart gives the percentage ground cover provided by six species planted in large blocks. Is that correct?

MR. MARSHALL: Well, he hasn't got the document.

MR. HOLLINGWORTH: Well, perhaps then, Mr. Commissioner, to pursue this line of questioning I should have a copy of this made, if we could take a short break at this point and I'll just go and have it done by the office here.

THE COMMISSIONER: All right.

MR. HOLLINGWORTH: Thanks.

THE COMMISSIONER: While you're doing that, Miss Minning, maybe I've forgotten earlier, you said that if you built this pipeline along the coastal route, the prime route, you would require 23 million cubic yards of borrow material, that would be quarried or mined from 98 sites. Then you said you'd need another 7 million cubic yards of borrow material for the actual trenching and backfill and so on. Would you need additional sites ? I don't know whether --

WITNESS MINNING: No, those are shown, or included in slides that are on the strip maps already. Most of the compressor sites will have a borrow site for that compressor site, but there are also borrow sites between compressor sites in the areas where these measures will be most often needed.

THE COMMISSIONER: Miss Minning, sorry, while we are looking for these documents. The 98 sites, the most important category is obviously glacial fluvial, then alluvial flood plains, fans and terraces are important as well, along with bedrock, morainal much less important and glacial lacustrine. though it is a category it doesn't have any... A. It probably shouldn't have been included on the chart.

Q. Just to make sure I understood those slides you showed us. Would the Eskers be glacial fluvial? A. Yes, they are.

Q. And the alluvial flood plains, fans and terraces speak for themselves then. Those three categories on the left hand side of the chart, bedrock presents the least problems I take it of those three categories to the environmental impact. The bedrock quarries, or scources of borrow. whatever you would call them, would be less likely to be associated today with the movement of water. or am I wrong about that? A. That is correct, but there are environmental concerns with the bedrock sites, particularly the raptors. Alyeska has found problems with bedrock sites too and its access roads are longer.

Q. Oh yes, but we were concentrating on - - at least the slides seemed to emphasize the problem of removing borrow from streams and rivers. Are you ready to...?

MR. MARSHALL: Sir, on that point, since you have raised it. I guess I have not made it clear in going through the questions with the panel. I think Mr. Hemstock or Dr. McCart might wish to comment on this, but I think the feeling of the panel is that by and large the sites in the active channels of rivers may be in many cases preferrable from an environmental point of view over, say, those that would be in bedrock because, as Dr. McCart has indicated after a couple of years you can't even tell that there has been a borrow operation there.

THE COMMISSIONER: You said active channels of rivers. I thought you weren't taking any borrow from the active channels of rivers?

MR. MARSHALL: I am sorry, active flood plains.

THE COMMISSIONER: Well, yes, I understand that and I understand that the problem of access to bedrock sites and disturbance of birds, or some other form of life might well be important. I was just trying to grasp the significance of what we have seen with the slides. At any rate, no doubt they will come to that in do course and if they don't we'll raise it with them. Mr. Scott, you might cover that. Make sure it is not overlooked. Well, back to you then I think, Mr. Hollingworth.

MR. HOLLINGWORTH: Q. Mr. Dabbs, you have the table in front of you now and it shows, as I understand it six species the Puccinellia, Deschampsia, Arctagrostis, Poa Glaucantha, Nugget bluegrass and Deschampsia, is that correct? A. It does.

Q. And of those puccinellia, deschampsia, poa glauca, and deschampsia are the two different varieties there, are native varieties. Is that correct?

A And so is Arctic red fescue.

Q Well, there's a certain amount of debate on that, isn't there? Some consider it native species and others do not. Is that correct?

A Arctic red was selected from the native stem stock from the State of Alaska, which are native.

THE COMMISSIONER: Can I have a copy of this piece of paper?

MR. HOLLINGWORTH:

A : I'm sorry, Mr. Commissioner. I don't believe there are English names for most of these.

MR. HOLLINGWORTH: Q Well, in any event, Mr. Dabbs, nugget bluegrass definitely is not a native species, isn't that correct? It's agronomic.

A Well, of course I'm trying to incorporate here -- you're confusing species with varieties.

Q I'm sorry, I'm obviously not a biologist. I will say "variety" from now on, and thank you for the admonition.

A Your questioning here nugget blue is not native to Prudhoe Bay where this work was done.

Q Well, don't these native varieties show substantial ground cover which in the first year, that is to say 1973 and still in some cases still more substantial coverage in 1974 with the great exception of nugget bluegrass, which has declined substantially in '74?

A Yes, the data show that. I have also visited all of these spots personally and I would like to just point out the difference between the research conditions that we're discussing here, where it points out in the heading, on a scraped site. That site was prepared as a garden site with scraping and rototilling of the upper organic material into the substrate just for clarification of the line of questioning.

Q Well, excuse me, but wouldn't the pipeline mound be essentially a scraped site?

A Scraped in this sense means that we scraped the living material off, leaving about a foot of organic material and then rototilling that in, which is -- and that's a level or slightly depressional area as opposed to the raised mound

situation of a backfill.

Q Well, are you saying then that these test results are only significant in relation to a scraped site and would not be in general terms?

A No sir, I interjected this only for the purpose of clarifying this situation, as we accept these data, as you referred to page 7 of Appendix "C", I point out the exact same -- or Dr. Younkin pointed out the exact same findings in these same species as named, some of the hardiest and best covered producers.

Q Well, why is it so essential to have agronomic varieties to establish good coverage, if you've got this sort of cover as indicated on this table, after such a short period of time with native species?

A Well, that worked very well there. I'd like also to point out the research findings from Inuvik, gained by Dr. Younkin which is reported -- and we're talking the same topic here -- in Progress Report on CAGSL re-vegetation studies north of 60, September 1974.

MR. MARSHALL:
Sir, I believe this report is included in the list of reports that Mr. Dabbs is relying upon. It had not got into a supplemental list of reports and studies yet, so perhaps it would be appropriate to have it entered as an exhibit, as the witness is referring to it, and if Mr. Hollingworth requires a copy we can have one.

Clark, Dabbs, Harlan, Hemstock, Koskimaki, McCart, Minning, Williams
Cross-Exam by Hollingworth

MR. HOLLINGWORTH: I would like a copy, Mr. Marshall. Where did you say this was listed, just to clarify it for me?

A List of publications I used in preparation of my testimony. It should be there.

Q Would that be in the literature cited at the end of Appendix "C", or would it be in your list of documents?

A List of documents.

Q After your qualifications.

A For the purpose of the record I could simply read the pertinent paragraph, I think that would be helpful in this case. Page 37, Section 5, of the Progress Report entitled:

"Native Species, Success in Field Trials at Inuvik and Tuktoyaktuk, N.W.T."

MR. MARSHALL: Just before you read that in, the reference would be found at [illegible] that would be to Appendix "C" where this report is listed.

A. Yes.

MR. MARSHALL: To make the record clear, sir, the reference to the report that Mr. Dabbs wishes to quote from is found at page 16 of Dr. Younkin's report, which was Appendix "C" to the testimony of the panel. Now the paragraph at the bottom of the page reads,

"At the end of the first summer all species referring to the species listed above, which were

fairway crested wheatgrass, nugget Kentucky bluegrass, Artared creeping red fescue, Kall orchardgrass, frontier Reed canarygrass, Engmo timothy, and the two native grasses, the common name, tall Arctic grass or specific name, Arctagrostis latifolia and bluejoint, which is known as calamogrostis canadensis." I'm sorry, I'll start the paragraph again.

"At the end of the first summer all species were clipped and weighed except for the two native grasses, which were considered too small. By the end of the second summer, 1972, the native grasses had become better established along with Artared creeping red fescue and nugget Kentucky bluegrass were considered the most successful species."

That was reported in Hernandez in his report of 1973, and his root work had been established by Younkin while a graduate student under Dr. Bliss at the University of Alberta.

When inspected again in 1973 the same four species were the most successful, the remainder having died or slowly showing only marginal survival . After a relatively slow start, the two native grasses appeared to be quite successful and it was decided to clip sections of the four main species to determine their net annual above-ground production.

Now, in the like of this and work reported by Mitchell & McKendrick also paid for by Artic Gas, having visited both these sites myself and Younkin having visited both sites, we conclude that the most appropriate approach at this time, until there is further evidence to prove otherwise is to attempt to gain the best of both worlds, that is to use the more rapidly establishing agronomic varieties, if you wish to use the phrase, and the native species, which are pioneer species which normally invade seismic disturbances, natural disturbances in the area, which will thus place the right-of-way into an early successional state and result in a stable plant cover.

MR. MARSHALL: I will have Mr. Dabbs make a photocopy of the passage that he was quoting from, sir, and provide it to the court reporters.

MR. HOLLINGWORTH: Q Well, turning back to Table 7 then, Mr. Dabbs, doesn't this show that native varieties grow just as quickly as agronomic ones? A. In this particular test, yes.

Q. Are you saying that there is something unique about this test that should be ignored? A. No. I am suggesting that there is other evidence that suggests the need for a slightly different approach that's all.

Q. All right, thank you. A. I have complete confidence in Dr. Mitchell's data.

Q. Now, on page 7 of Appendix C, if you wouldn't mind turning to that. A Yes, I have it.

Q. The statement made in Paragraph 4, point 1, point 2, that with the native grasses you are having problems with the dormancy and flowering mechanisms, is that correct? That is about three-quarters of the way down the paragraph. This is before you can develop commercial quantities of the seed. A. Yes, I have that.

Q. That is with particular reference to two native species, varieties Arctagrostis latifolia and Calamagrostis canadensis, is that correct?

A. That's right.

Q. What exactly are these problems that you are having? Could you be more specific? A. Certainly. The program which Artic Gas has sponsored and it is now a second sponsorship here, the Northern Affairs Department, is one that we started with a collection of seed, the eco-type types of those two species from Fort Simpson through to Tuktoyaktuk, all of these of course being kept separate because of the genetic variability within the eco-types. The program for multiplication has been one where we find it economically attractive to attempt in northern Alberta, where is can be done under somewhat normal agricultural production conditions, and in this case we are bringing seed of eco-types adapted to very long or continuous daylength into an area of less than twenty-four hour daylength. Fort Vermilion I believe is rated at about nineteen and a half hours of twilight by the Environment of Canada, Met Branch, so we are dealing with something in a shorter day length. If these are to be produced in any large quantities on an agricultural basis, they have to be able to grow within an area that, or we believe they have to be grown within an area such as the Fort Vermilion - Le Grate area, which is about as far north as feasible agricultural production takes place, and the statement relates to that, the problem of dormancy in flower mechanism. Flower mechanism being that plants from a twenty-four hour daylight regime may not flower and may not set seed under an eighteen hour daylight.

However, to cover that we have established plots within the Mackenzie Delta proper, near Taglu, which obviously compensates for that problem.

Q. When you say they might not flower and they might not seed are you sure of that, or is this just a suspicion that you have, or have results over many years shown that they are not doing it?

A. The results of the Ph. D. research and thesis written by Younkin at the University of Alberta was specifically on the onecology of these two species. He has worked on these species for a large number of years and this is his report. Now, I am familiar with his findings and it is Dr. Younkin's findings that, for instance that Arctagrostis from Tuk probably requires twenty-four hours daylength to flower and set seed, consequently, selections taken from that area would have to be grown within the, probably the Mackenzie Delta, whereas selections of Calamagrostis from the Fort Simpson area and Norman Wells area flower perfectly well under the shorter daylight.

Q. Now, also on that page 7 you make reference to about five native varieties. That is on page 7 of Appendix C. A. Yes.

Q. All right. Have you produced seed at all in, or in commercial quantity from any of those varieties? A. Of the two names varieties?

Q. No, of the five that are mentioned on page 7. We are speaking of Puccinellia, Arctagrostis latifolia, Calamagrostis canadensis, Deschampsia and Poa Glaucantha. A. Those five that are listed there are from the works of Dr. Mitchell, who is acting

as a consultant for Artic Gas and he has produced some though I am not certain all of those are possible yet on a commercial basis, but he has acreage of several those under production in the Palmer - Alaska area right now, but of those other three, other than Arctagrostis and Calamagrostis, no, we are not dealing with those, as Mr. Mitchell is working with them.

Q. Do you have any seed of the Arctagrostis latifolia and Calamagrostis canadensis varieties at the moment? A. I would like to produce -- We have not yet produced any. The field plots were only established in mid-summer, 1974. The seed we have on hand has been collected from native stands.

Q. Well, on page 52 of the -- maybe it is the same document you are referring to "Progress Report on CAGSL Re-vegetation Studies North of 60" by Younkin and Friesen, dated September '74. A. Yes.

Q. You have that page reference in front of you? A. Yes.

Q. You speak there of having approximately 236 pounds of Arctagrostis and 28 pounds of Calamagrostis, or enough to plant 75 acres of Arctagrostis and 9 acres of Calamagrostis. Am I reading that correctly? A. Yes, you have read it correctly. I am just reading it.

THE COMMISSIONER: What I want to know is why isn't Mr. Gibbs here to ask these questions about crops?

MR. HOLLINGWORTH: He is bringing in his own, sir.

MR. MARSHALL: He specializes in hay, sir.

THE COMMISSIONER: Well, I think maybe we might adjourn for the day. We are cheating ourselves of forty-five minutes, but maybe we can make it up tomorrow or later in the week and we will all be a little fresher tomorrow.

MR. HOLLINGWORTH: Mr. Dabbs can think about that one overnight.

MR. MARSHALL: I'm sure he'll think of little else.

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